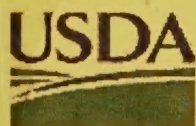


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United States
Department of Agriculture



Forest Service
Pacific Northwest Region

Douglas-fir Tussock Moth


Final Environmental Impact Statement



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PACIFIC NW REGION DOUGLAS-FIR TUSSOCK MOTH Final Environmental Impact Statement

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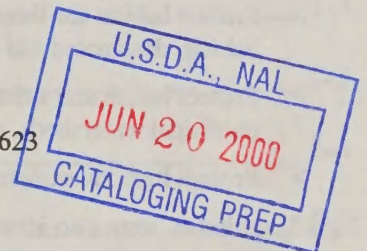
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Website: http://www.fs.fed.us/r6/nr/fid/eisweb/dftm_eis.htm





Douglas-fir Tussock Moth in the Pacific Northwest Region

ABSTRACT: The USDA Forest Service, Pacific Northwest Region, proposes to implement a management strategy that would partially control an anticipated outbreak of Douglas fir tussock moth, *Orgyia pseudotsugata* ("DFTM"). This strategy would be implemented on nine National Forests in Washington and Oregon: the Colville, Okanogan, Wenatchee, Umatilla, Wallowa-Whitman, Malheur, Ochoco, Winema, and Fremont. The anticipated outbreak could affect 700,000 acres or more of National Forest lands and could result in partial or complete defoliation of Douglas-fir and true fir trees.

The goal of this project is to maintain vegetative conditions of forested areas of concern that are at risk from defoliation from Douglas-fir tussock moth. These areas include aquatic and terrestrial species habitat, areas for human use and enjoyment, and administrative areas. Project objectives are:

- Protect habitat for threatened and endangered species, specifically salmon, steelhead, bull trout, wildlife nesting habitat, designated old growth, and late and old structural stands
- Protect health and safety areas, including residential and administrative areas, high use developed recreation areas, municipal watersheds, and designated scenic areas.
- Protect high investment areas, such as seed orchards and areas currently being protected from bark beetles.

Significant issues were also identified during public scoping in September and October 1999. They are:

- 1) Human health effects from contact with the larvae, and from spraying.
- 2) Protection of timber values.
- 3) Possible effects on non-target Lepidoptera (moths and butterflies).
- 4) Forest Health.

This document analyzes three action alternatives and a "no action" alternative. The Proposed Action would protect Areas of Concern from defoliation by Douglas-fir tussock moth. It would protect these areas by spraying *Bacillus thuringiensis*, var. *kurstaki* (B.t.k.), a naturally occurring bacteria, or TM-BioControl, a naturally occurring virus. The Expanded Protection Alternative would protect all areas identified in the Proposed Action plus all areas with 60-100% host type trees, excluding Wilderness. B.t.k. and TM-BioControl would be used. The TM-BioControl Only Alternative would protect the same areas as the Proposed Action, but with the TM-BioControl insecticide only. There would be no protection with implementation of the No Action Alternative. In the No Action Alternative and on all unprotected land in the other three alternatives, the tussock moth would be allowed to follow its natural course of population build up and decline on all affected National Forests.

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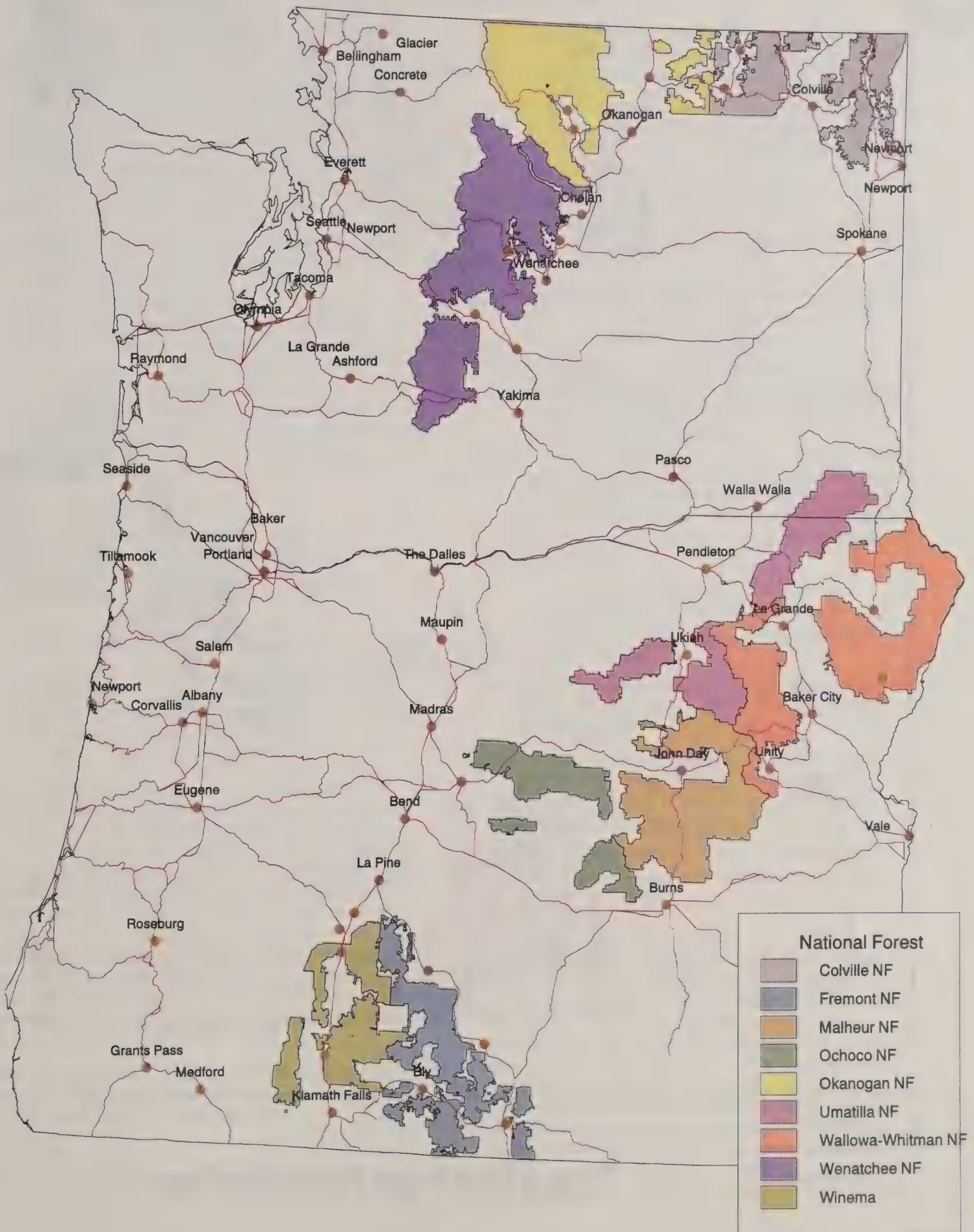
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Tussock Moth Project Forest





- National Forest
- Wilderness Lands
- Host Type

Tussock Moth Project Forests Host Type



EXECUTIVE SUMMARY

INTRODUCTION

This environmental impact statement discusses the direct, indirect, and cumulative impacts to the environment that could result from efforts to control an anticipated outbreak of Douglas-fir tussock moth, *Orgyia pseudotsugata*, on portions of nine National forests in Oregon and Washington: the Colville, Okanogan, and Wenatchee in Washington; and the Umatilla, Wallowa-Whitman, Malheur, Ochoco, Fremont, and Winema in Oregon.

The Douglas-fir tussock moth is a native insect that feeds on needles of its host trees, Douglas-fir, true fir and white fir. They are always present in the environment. Populations of this insect periodically reach outbreak levels and can cause significant damage in some areas when it does. The outbreaks arise suddenly and last for only 2-4 years, but can cause significant defoliation. According to data from the early warning trapping system, populations have been increasing. This trend appears to be more widespread than previous, more localized outbreaks. It is anticipated that a widespread Douglas-fir tussock moth outbreak will occur in the next 5 years.

PURPOSE AND NEED

The GOAL is to maintain existing vegetation conditions and protect specific resources that are at risk from Douglas-fir tussock moth defoliation for the short-term until long-term management actions restore natural forest conditions over the landscape.

The NEED exists to protect specific areas of concern where the tussock moth where tussock moth defoliation would change or jeopardize vegetative conditions for resources such as Threatened and Endangered species habitat, health and safety areas, and areas where the Forest Service has made substantial investment.

This EIS is being prepared in advance of an anticipated Douglas-fir tussock moth outbreak; it is not known exactly where the outbreak will occur, but when an outbreak occurs, it will happen very suddenly. We have identified and are analyzing effects on all acres that could *potentially* be affected by Douglas-fir tussock moth defoliation and subsequent tree mortality. It is certain that the outbreak will only occur on parts of the acres in any of the alternatives. Although many acres are being analyzed, if an action alternative is selected, it would only occur on areas with increasing Douglas-fir tussock moth populations. Many of the areas in this analysis will, in fact, never experience outbreak populations.

Acres analyzed under this EIS are all acres with the host type (Douglas-fir, true fir and white fir). The number of acres analyzed varies with each alternative.

Objectives

- Protect riparian habitat where defoliation would cause unacceptable degradation of occupied habitat,

especially critical spawning or rearing habitat for salmon, steelhead, and bull trout (loss of shade, increased sedimentation, etc.).

- Protect nesting, roosting, and foraging habitat for Spotted Owls where defoliation would reduce total crown closure so that an area could no longer function as a reproductive/fledgling site.
- Protect areas within designated Northwest Forest Plan Late Successional Reserves ("LSRs") where habitat needs to be maintained until the overall quality of that habitat improves.
- Protect designated old growth and late/old structure ("OG/LOS") stands where defoliation would substantially degrade habitat values.
- Protect residential and administrative sites where defoliation and the presence of large numbers of larvae would adversely affect people living or working there. This would include work centers, special use permit summer home sites, resorts, or established camps. Protect high use recreation sites where defoliation and the presence of large numbers of larvae would adversely affect many forest visitors. This would include campgrounds, picnic areas, and interpretive sites.
- Protect municipal watersheds where an existing formal agreement is in place and where 100% defoliation would have unacceptable impacts on water quantity or quality.
- Protect designated foreground scenic areas of concern where defoliation would have a substantial adverse impact on scenery.
- Protect seed orchards and plantations of genetically superior trees where defoliation would result in a considerable loss of investment and a reduction of seed needed for future seedling demand.
- Protect areas where investments have already been made to protect Douglas-fir or other firs from bark beetles.

Two biological insecticides have been identified for use, if control of Douglas-fir tussock moth populations is warranted. These are *Bacillus thuringiensis* var. *kurstaki* (B.t.k.) and TM-BioControl. They would be applied primarily as an aerial application, although some ground application could also occur. B.t.k. is a bacterium that occurs naturally in the soil. It is specific to Lepidoptera (moths and butterflies). It must be eaten by the caterpillar stage of these insects in order to be effective. Effects on species varies. TM-BioControl is an insecticide that is made of the natural virus of the tussock moth. This virus occurs naturally and is the primary cause of the collapse of

Douglas-fir tussock moth outbreaks under natural conditions. This virus is specific only to Douglas-fir tussock moth and three other species of tussock moths.

PUBLIC SCOPING AND COMMENT:

A Notice of Intent for this EIS was published in the *Federal Register* in June 18, 1999. Public Scoping and comments were received until August 20, 1999. Issues were identified and alternatives were developed based on the public comments. The Draft Environmental Impact Statement was issued in January with public comments received until Feb 29, 2000.

ISSUES

Issues were identified by an Interdisciplinary Team (IDT) of Forest Service resource specialists, based on input received during the public scoping process. Significant Issues had the greatest influence during the development of alternatives. Both the Significant and Other Issues are used in the decision-making process.

1. Human Health Effects: There are many areas of human use not included in the Proposed Action, such as dispersed recreation areas, less used campsites, fishing spots, and general forest areas. Human health could be affected through direct contact with larvae. In addition, there was the concern of possible effects on human health from the spraying.
2. Protection of Timber Values: Areas not included in the Proposed Action that contain commercially viable timber need to be protected to prevent mortality and loss of timber value.
3. Non-Target Lepidoptera: B.t.k. could kill larvae of non-target Lepidoptera.
4. Maintaining Healthy Forests: a) Allow the natural cycle of tussock moth to thin out Douglas-fir and true fir trees, thus restoring a "healthy ecosystem"; b) Protect forests from tussock moth because dead or dying trees are a sign of an "unhealthy forest".
5. Fuel Build-up and Fire Risk: In unprotected areas, additional fuels could increase the risk of ignition and catastrophic fire.
6. Effects of Spraying on Fish and Wildlife: Wildlife or fish could ingest insecticide.
7. Water Quality: a) Defoliation of unprotected riparian areas could affect stream temperature, peak flows, sediment input, etc.; b) The insecticide could pollute streams and lakes.
8. Economic Effects from Decreased Tourism: Protection of recreation areas could help local communities by maintaining tourist and recreation income.

9. Tussock moth larvae could increase the food supply for wildlife species: Killing tussock moth larvae could reduce the opportunity for certain wildlife to take advantage of a food surplus.
10. Operations: Spraying could cause environmental problems or limit access to the forest during operations. Examples include fuel spills, helicopter crashes, noise, and road closures during operations.
11. Secondary Mortality: Weakened trees that survive the tussock moth infestation could die from secondary attacks by bark beetles or other forest pathogens.

ALTERNATIVES CONSIDERED IN DETAIL

Four alternatives were considered in this analysis:

No Action Alternative – This alternative would allow the Douglas-fir tussock moth outbreak to occur naturally. All acres with 20% or more host type were analyzed under this alternative.

Proposed Action – This is essentially the Proposed Action that was described during Public Scoping. In this alternative, specific areas of concern, as identified by the above objectives, would be protected from defoliation. A total of 628,000 acres were analyzed under this alternative. The areas of concern vary in size and location throughout the Forests, and range from a total of 190 acres analyzed on the Fremont NF to 130,000 acres analyzed on the Umatilla NF. Table 1, below identifies the number of acres analyzed for the areas protected under the proposed action.

Expanded Protection Alternative – This alternative was developed as a result of Public Scoping. Primary public concerns that influenced the development of this alternative were the need to maintain a healthy forest, protection of timber values, and protection of dispersed recreation sites. The acres in this analysis include the acres for the areas of concern in the Proposed Action, and in addition, all acres with 60% or more host type. A total of 2,505,220 acres are analyzed under this alternative. Table 2, page I-iv, shows the acres analyzed in the Expanded Protection Alternative.

TM-BioControl Only Alternative – This alternative was developed in response to the public comments from the Draft Environmental Impact Statement. It analyzes the same acres that are in the Proposed Action, but considers only using TM-BioControl. There is some risk with this alternative because there is a limited supply of TM-BioControl available.

COMPARISON OF ALTERNATIVES

Please see Ch. II, Comparison of Alternative, Table II-3, for a complete review of all alternatives.

Table 1: Areas Protected under the Proposed Action and TM-BioControl Alternative, in acres

FOREST→	COL	OKA	WEN	UMA	W-W	MAL	OCH	WIN	FRE ¹	TOTAL
Bark Beetle Protection	0	0	3,260	0	800	3,600	0	0	0	7,660
Fish – Anadromous	0	0	1,230 (18 miles)	27,610 (179 mi.)	6,490 (92 miles)	2,170 (31 mi.)	7,190 (102 mi.)	0	0	0 422 mi.
Fish - Bull Trout	0	270 (4 mi.)	340 (5 mi.)	23,380 (98 mi.)	6,010 (85 mi.)	2,700 (39 mi.)	0	0	190 (3 mi.)	32,890 (234 mi)
Late Succ. Reserves (LSRs)	0	16,600	74,800	0	0	0	0	0	0	91,400
Nesting Hab. Spotted Owl	0	3,000	32,000	0	0	0	0	1,600	0	36,600
Nesting Habitat Bald Eagle	0	0	0	50	0	0	0	0	0	50
Old Growth	0	0	0	18,570	17,660	14,950	55,450	23,100	0	129,730
Late & Old Structure				17,200	83,440	28,860	64,680			194,180
Recreation: high use areas	7,100	1,940	110	3,230	10,940	140	4,200	20	0	27,680
Residential & Admin.	0	120	8,650	940	0	60	240	150	0	10,160
Scenic	0	98,130	4,840	67,270	0	33,630	7,650	0	0	211,520
Seed Orchards	150 (5 Orchards)	420 (2 Orch.)	0	180 (3 Orch.)	360 (6 Orch.)	0	0	0	0	935
Municipal Watershed	0	0	0	12,280	8,740	150	540	0	0	21,710
Other	0	0	610	20	0	14,860	0	1,510	0	17,000
Total ²	7,260	122,070	93,330	130,310	110,520	72,910	66,680	24,610	190	627,880

¹ Includes the Demming Creek watershed only.

² The columns do not necessarily add up to the "Total" acres since there is some overlap among Area of Concern categories.

Table 2: Areas Protected under the Expanded Action Alternative, in acres

FOREST→	COL	OKA	WEN	UMA	W-W	MAL	OCH	WIN	FRE	TOTAL
Areas of Concern protected in Proposed Action & TM-BioControl Alt.	7,260	122,070	93,330	130,310	110,520	72,910	66,680	24,610	190	627,880
Additional Acres Protected this Alt.	551,190	261,690	31,570	349,530	368,550	260,980	6,570	46,590	660	1,877,330
Total, this Alt.	558,450	383,760	124,900	479,840	479,070	333,890	73,260	71,200	850	2,505,220
Total Acres of 20-60% Host Type Not Protected	621,560	493,170	176,620	931,870	959,700	706,070	112,700	237,350	3,710	4,242,750

Chapter I: PURPOSE OF and NEED FOR ACTION

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SUMMARY OF CHANGES BETWEEN DRAFT AND FINAL

A more detailed description of the biological control agents, B.t.k. and TM-BioControl, was added or relocated from various Appendices and Chapters.

Objectives and Issues were clarified and identified earlier in the Chapter.

The Proposed Action was clarified.

Removed most Wilderness areas from the Proposed Action.

Removed project objectives concerning eagle nesting habitat and previously awarded timber sale areas.

Clarified that protection would not occur in Natural Research Areas.

There is no "preferred" alternative in this Final EIS.

REPORT OF THE BOARD OF DIRECTORS
FOR THE YEAR 1964

The Board of Directors of the Corporation has the honor to submit to the stockholders the following report for the year 1964. The Corporation has achieved significant progress in its operations and financial performance during this period. The Board has been actively engaged in the management of the Corporation and has taken various measures to improve its efficiency and profitability. The financial statements show a steady increase in revenue and a decrease in expenses, resulting in a net profit for the year. The Board also wishes to express its appreciation to the management and the stockholders for their support and cooperation throughout the year.

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INTRODUCTION

This environmental impact statement discusses the direct, indirect, and cumulative impacts to the environment that could result from efforts to control an anticipated outbreak of Douglas-fir tussock moth, *Orgyia pseudotsugata*, on portions of nine National Forests in Oregon and Washington.

The Douglas-fir tussock moth ("DFTM") is a tree defoliator – in the larval stage, it lives by eating needles of live trees. It attacks Douglas-fir (*Pseudotsuga menziesii*) and "true" firs: grand fir (*Abies grandis*), subalpine fir (*Abies lasiocarpa*), and white fir (*Abies concolor*). Tussock moth populations are cyclic, with an epidemic every 7-13 years. Each outbreak lasts 2-4 years and ends with a sudden crash. The outbreaks usually occur in mature and over-mature multi-story stands with a high density of host trees. Trees on ridge tops and south facing slopes are the most vulnerable because of the stress from a generally drier location.

Tussock moths are always present in the environment. Since the female moth is incapable of flight, tussock moth outbreaks generally arise in place, with little or no spread into uninfested or previously treated areas. If an outbreak occurs, it is because DFTM populations are already on site, and conditions are favorable. Populations too low to be detected one year can erupt into destructive populations the next. Once populations explode, substantial damage can occur before land managers are able to implement management options. Because of an outbreak in the early 1970s, the United States Department of Agriculture initiated a program to research the moth. The objective was to better anticipate future outbreaks and to develop management options. One result of this program was a



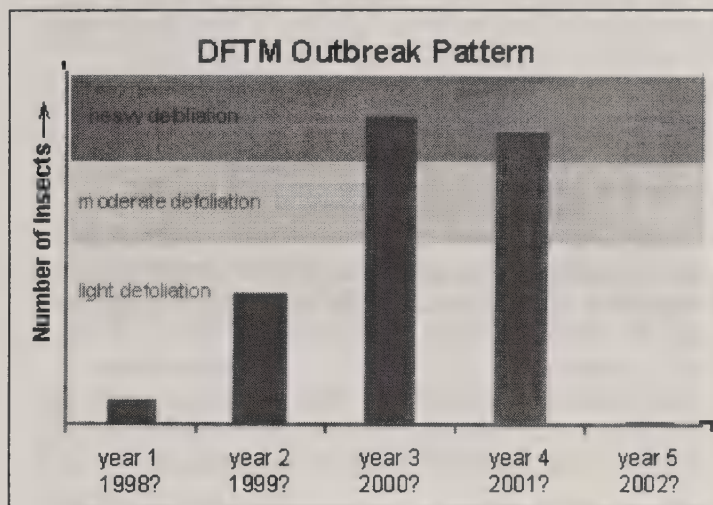
Photo I-1: Moth Trap

survey technique, the "Douglas-fir Tussock Moth Early Warning System", to monitor population trends. Tussock moth traps (photo, left) are placed in forests throughout eastern Washington and Oregon. The number of captured male moths helps gauge the overall moth population. During a non-

outbreak year, it is common to have very few or no moths in most traps. Ground sampling is initiated when average capture exceeds 40 moths/trap.

In the Pacific Northwest, a tussock moth population increase consists of four phases (see Outbreak Pattern graph). During the first phase, the population begins to build but remains below outbreak levels. In phase II (shown as year 2), populations increase to outbreak levels and light defoliation becomes apparent. By phase III (year 3), populations are extremely high and there is widespread tree defoliation. During phase IV (year 4), viral infection, competition, predation, and parasitism cause the population to collapse. Thereafter, predators and parasites maintain the DFTM populations at low levels during non-

outbreak years (shown as year 5). Affected trees may continue to die for several years following defoliation due



to secondary effects of bark beetles or other insects.

In the past, tussock moth outbreaks were treated by spraying insecticide after significant defoliation became evident. Specialists now know that for treatment to be effective, it must occur from mid-June to mid-July (when larvae are actively feeding) and before heavy defoliation becomes apparent (i.e. early in phase III). Since 1974, populations have fluctuated twice without reaching outbreak levels except for a few places in eastern Oregon. A 1991 outbreak was treated with *Bacillus thuringiensis kurstaki*, commonly known as B.t.k.

According to data from the "early warning" system, DFTM populations have been increasing. This trend appears to be more widespread than the previous localized outbreaks. Within the next few years, outbreaks could occur on nine Pacific Northwest National Forests: the Colville, Fremont, Malheur, Ochoco, Okanogan, Umatilla, Wallowa-Whitman, Wenatchee, and Winema. The analysis in this document covers only National Forest lands. The anticipated outbreak is expected to occur primarily in the years 2000-2002 and could last through 2004. Defoliation could be similar to the 1971-1974 outbreak. In many places, DFTM would act as a natural disturbance agent by reducing overstocking and creating stand openings. The "early warning" merely provides an opportunity to evaluate potential impacts on specific areas (riparian areas, campgrounds, etc.) where foliage protection might be critical. It also allows the Forest Service to evaluate possible effects of short-term management strategies on specific sites.

SCOPE OF THIS DOCUMENT

This environmental impact statement examines several alternatives that the Forest Service could use to manage a tussock moth outbreak in Oregon and Washington. The document only provides guidance for situations in which the Forest Service would actively protect National Forest lands. The actual tussock moth outbreak would probably

occur on other federal, state, and private lands. This EIS does not attempt to analyze impacts on those lands, however, information in this document may be useful to other land managers when planning actions that are a consequence of the outbreak. Actions of other landowners to manage tussock moth on their own lands are not constrained by this document. Typically, state forestry programs help private landowners deal with forest pest problems. The Forest Service remains available to cooperate with these landowners whenever possible.

The options discussed in this analysis represent short term management strategies to maintain existing vegetation conditions in specific areas and to protect specific resources until long term management actions restore natural forest conditions over the landscape. It is not the intent of this EIS to attempt to stop or prevent the overall tussock moth outbreak, or to prevent defoliation over the entire area where the outbreak may occur.

PURPOSE AND NEED

Based on the "early warning" monitoring system, an outbreak of Douglas-fir tussock moth is anticipated in the next several years. The tussock moth typically defoliates trees in patches, sometimes over large areas, which can result in significant tree mortality. If this outbreak is as intense as anticipated, it could be similar to an outbreak in the early 1970s when approximately 700,000 acres were defoliated in Oregon, Washington, and Idaho. This outbreak saw approximately 17,270 acres of total mortality in patches, and 75 % tree mortality over 62,070 acres, and 10 % tree mortality over 275,660 acres (USDA Forest Service, 1974).

Goal: To maintain existing desired vegetative conditions in Areas of Concern that are at risk from Douglas-fir tussock moth defoliation within the next two to five years. These areas include but are not limited to aquatic and terrestrial species habitat, areas for human use and enjoyment, and administrative areas.

Need: The need exists to protect specific Areas of Concern where tussock moth defoliation would change or jeopardize vegetative conditions in Threatened and Endangered (T & E) species habitat, health, and safety areas, and areas where the Forest Service has made substantial investments (such as a seed orchard). Preserving this vegetation would maintain desired habitats for fish and wildlife, preserve campgrounds, and maintain important scenic viewsheds. Additionally, there is a concern for public health. The hairs on the larvae can cause welts, rashes, and other allergic reactions in some people.

Though the alternatives specify acres that would be protected if an outbreak occurred in those areas, this does not mean that blanket spraying would occur. Spraying would only occur where tussock moths increased to sub-outbreak or outbreak population levels in areas identified in the selected alternative within the next five years as specified in the alternative selected.

Objectives:

- Protect riparian habitat where defoliation would cause unacceptable degradation of occupied habitat, especially critical spawning or rearing habitat for salmon, steelhead, and bull trout (loss of shade, increased sedimentation, etc.). The criterion to measure the effects of each alternative and to compare alternatives is the number of miles of stream protected from defoliation within host type where defoliation results in unacceptable degradation of occupied habitat especially important spawning and rearing habitat.
- Protect nesting, roosting, and foraging habitat for Spotted Owls where defoliation would reduce total crown closure so that an area could no longer function as a reproductive/fledgling site. The criteria to measure the effects of each alternative and to compare alternatives are the number of Spotted Owl activity centers protected within host type where defoliation results in unacceptable degradation of nesting, roosting, and foraging habitat.
- Protect areas within designated Northwest Forest Plan Late Successional Reserves ("LSRs") where habitat needs to be maintained until the overall quality of that habitat improves. The criterion to measure the effects of each alternative and to compare alternatives is the number of acres of LSR protected where the defoliation of LSR results in unacceptable loss of late successional habitat within the LSR.
- Protect designated old growth and late/old structure ("OG/LOS") stands where defoliation would substantially degrade habitat values. The criterion to measure the effects of each alternative and to compare alternatives is the number of acres of old growth / LOS protected where the defoliation of these stands results in unacceptable degradation of their habitat values.
- Protect residential and administrative sites where defoliation and the presence of large numbers of larvae would adversely affect people living or working there. This would include work centers, special use permit summer home sites, resorts, or established camps. The criterion to measure the effects of each alternative and to compare alternatives is the number of sites protected where the presence of the larvae would adversely affect people where they live or work, or would cause unacceptable degradation of the environment in the area.
- Protect high use recreation sites where defoliation and the presence of large numbers of larvae would adversely affect many forest visitors. This would include campgrounds, picnic areas, and interpretive sites. The criterion to measure the effects of each alternative and to compare alternatives is the number of sites protected where the presence of the larvae would adversely affect concentrations of forest

visitors, or would cause unacceptable degradation of the environment in those areas.

- Protect municipal watersheds where an existing formal agreement is in place and where 100% defoliation would have unacceptable impacts on water quantity or quality. The criterion to measure the effects of each alternative and compare alternatives is the estimated potential for unacceptable degradation of water quality from increased sedimentation either from defoliation or from increased risk of secondary events such as fire.
- Protect designated foreground scenic Areas of Concern where defoliation would have a substantial adverse impact on scenery. The criterion to measure the effects of each alternative and to compare alternatives is the estimated acres of scenic foreground protected where defoliation would result in significant degradation of the designated scenic areas.
- Protect seed orchards and plantations of genetically superior trees where defoliation would result in a considerable loss of investment and a reduction of seed needed for future seedling demand. The criterion to measure the effects of each alternative and to compare alternatives is the number of orchards protected where unacceptable loss of investment and seed production would result.
- Protect areas where investments have already been made to protect Douglas-fir or other firs from bark beetles. The criterion to measure the effects of each alternative and to compare alternatives is the number of acres protected from defoliation that are currently being protected from bark beetles.

Note that the objective to protect Awarded Timber Sales described in the draft EIS was dropped. The reasons were 1) there are contract provisions to handle situations such as insect damage, and 2) sales identified to be protected were few and would be mostly harvested and logged within the year.

METHODS OF CONTROL

Two methods of control are evaluated in this document: treatment with a bacterial insecticide, B.t.k., and/or treatment with a viral insecticide, TM-BioControl. Use of either would achieve the desired insect suppression objectives. Both are registered by the U.S. Environmental Protection Agency.

B.t.k.: *Bacillus thuringiensis*, var. *kurstaki* is a bacterium that occurs naturally in the soil. When used as an insecticide, the bacteria spore and a toxic crystal produced by the spore are formulated into a liquid. The crystal is the primary active ingredient. In order to be toxic, the crystal must be ingested and activated by the alkaline gut system of a caterpillar. Once ingested, it causes paralysis of the gut system and the insect stops feeding. There are a number of varieties of B.t.; each is specific to certain insects. The variety *kurstaki* is specific to Lepidoptera

(moths and butterflies). B.t.k. is applied as a spray at 1/2 - 1 gal/acre.

B.t.k. is commonly used against a variety of forest defoliators and has been used to control DFTM. It was field tested against Douglas-fir tussock moth on various occasions in the early 1970s and was used operationally in 1989 on the Plumas NF. In 1991, 116,000 acres were treated for DFTM with B.t.k. on the Wallowa-Whitman NF. Between 1983 and 1993, it was used in a number of projects to control western spruce budworm on the Wenatchee, Umatilla, Wallowa-Whitman, and Malheur National Forests. Since Douglas-fir tussock moth and western spruce budworm both use the same host species, it is possible that many of the areas being considered for protection from Douglas-fir tussock moth have already been treated with B.t.k. once, and in some cases twice, in the past 15 years. The last B.t.k. treatment on any of these Forests occurred on parts of the Umatilla and Wallowa-Whitman Forests in 1992.

Field and laboratory testing has shown that certain insects can develop significant resistance through repeated exposure to B.t.k. However, it is unlikely that resistance would build up in tussock moth populations for a variety of reasons. B.t.k. has little direct effect on natural enemies and development of DFTM individuals that do not receive a lethal dose of B.t.k. is extended, allowing more exposure to natural parasites and viral infection. Furthermore, infrequent applications every 7 or 8 years, or longer, are generally not conducive to development of resistance.

TM-BioControl: Nucleopolyhedrosis virus (photo, right) is the natural virus of the Douglas-fir tussock moth. It is one of the most infectious viruses known and its role in the collapse of DFTM outbreak populations is well documented. It can persist in soil at very low levels between outbreaks,



Photo I-2: DFTM

and can remain viable for more than 40 years. Regardless of whether the Forest Service actively protects any lands under this project, this natural virus will eventually cause the Douglas-fir tussock moth outbreak to collapse. Complete resistance of tussock moth has never been found, either in extensive laboratory rearing or in field populations. If there were any resistance or natural selection for resistance against this virus, it would occur in response to the natural virus build up regardless of any applications of TM-BioControl. No resurgence of DFTM populations after treatment has ever been recorded. Besides Douglas-fir tussock moth, the virus affects only three other species of tussock moths.

The virus affects the gut system of the caterpillar, causing rapid death. In 1976, the USDA Forest Service registered this virus as a biological insecticide called TM-BioControl. The US Forest Service remains the sole producer, registrant, and owner of TM-BioControl. The powder is produced from infected caterpillars; it contains only the virus and ground-up insect body parts. It is mixed with water, molasses, a sunscreen, and a sticker (or a premixed

carrier called "038"), and is applied as a spray at 1 gal/acre. The Forest Service currently has an estimated 300,000 – 350,000-acre doses of TM-BioControl available.

TM-BioControl was used in DFTM suppression trials as early as the early 1960's. From 1970-1991, several studies of the virus in various formulations were conducted in Oregon, California, Idaho, and British Columbia. Each time, tussock moth populations were effectively controlled while populations in check plots continued to increase until the natural epizootic occurred. It was also used operationally in New Mexico in 1978 and 1979.

In all previous studies, trees treated with either B.t.k. or TM-BioControl sustained about 15 – 22% defoliation while untreated trees had about 63% defoliation.

In-depth risk assessments have been done for B.t.k.³ and TM-BioControl⁴, per National Research Council of the National Academy of Sciences recommendations.

SCOPING AND PUBLIC INVOLVEMENT

As required by the *National Environmental Policy Act*, 40 CFR 1501.7, a Notice of Intent ("NOI") was published in the *Federal Register* on June 18, 1999. This notice described the Forest Service proposal of managing the tussock moth outbreak and provided a 30-day comment period. Neither the nine National Forests nor the Regional Office received any comments during this period.

Following publication of the NOI in the *Federal Register*, each Forest sent a letter describing the Proposed Action and information specific to that Forest to interested citizens, organizations, businesses, and other governmental agencies on their mailing lists. Instructions in the scoping letters indicated that anyone wishing to comment on the Proposed Action should mail their comments to the Regional Office in Portland, Oregon. The Regional Office received 148 pre-addressed forms, individual letters, Internet contacts, and telephone comments. These came from private individuals, businesses, other governmental agencies, and organizations. Other public participation opportunities included interviews of Forest Service entomologists by Oregon Public Broadcasting, KPLU (Seattle, WA), and the *Walla Walla Union Bulletin*. Newspaper articles appeared in *The Blue Mountain Eagle* (John Day, Oregon) on June 30 and July 27, 1999; the *Bend Bulletin* (Bend, Oregon) on August 3, 1999; the *Baker City Herald* (Baker City, Oregon) August 10, 1999; and *The Oregonian* (Portland, Oregon) on August 11, 1999. These articles described the anticipated tussock moth outbreak and advised readers that the Notice of Intent was available, where to obtain a copy, and who to contact. Additionally, the Prineville-Crook County Chamber of Commerce included an article in their "Weekly Member Update" on August 2, 1999.

Please see Appendix C for more information.

PROPOSED ACTION

The Forest Service proposes to spray B.t.k. and/or TM-BioControl on portions of nine National Forests. Active protection would only occur where outbreak or sub-outbreak populations of larvae have been verified. Up to 628,000 acres could be protected. Those areas where defoliation would result in degradation of threatened or endangered fish and wildlife habitats, recreation areas, or other Areas of Concern would be targeted. The biological agents would be applied primarily from the air, although ground application could occur in specific areas such as seed orchards.

This action is not designed to control the outbreak across the entire host type on the nine National Forests, only to protect specific Areas of Concern within these Forests. This proposal assumes there are adequate resources (insecticide, equipment, funding, etc.) for treatment. This proposal does not consider lands adjacent to National Forests.

Testing or development of new suppression technologies, such as mating disruption, could occur at some experimental sites. Agency personnel would conduct these tests. Other agencies or organizations could be involved in the research.

The Proposed Action would fully meet the stated goal of maintaining the functionality of current or desired future conditions of the identified Areas of Concern. This would be accomplished by protecting Douglas-fir and true fir from defoliation and death. The existing condition of riparian habitats, key habitat areas for specific wildlife species, recreation areas, and other identified Areas of Concern would be maintained.

ISSUES

Issues were identified by an Interdisciplinary Team (IDT) of Forest Service resource specialists, based on input received during the public scoping process. **Significant Issues** had the greatest influence during the development of alternatives. Both the Significant and Other Issues are used in the decision-making process.

SIGNIFICANT ISSUES

1. Human Health Effects

The Issue: There are many areas of human use not included in the Proposed Action, such as dispersed recreation areas, less used campsites, fishing spots, and general forest areas. Human health could be affected through direct contact with larvae. In addition, there was the concern of possible effects on human health from the spraying. The following criteria will be used to measure the effects of each alternative and to provide a method for comparing alternatives:

- Estimated potential for human exposure to larvae.
- Estimated potential for human exposure to B.t.k. or TM-BioControl during and after spray operations.

2. Protection of Timber Values

³ *Programmatic Gypsy Moth Environmental Impact Statement*. USDA, 1995.

⁴ Syracuse Environmental Research Associates, Inc.

The Issue: Areas not included in the Proposed Action that contain commercially viable timber need to be protected to prevent mortality and loss of timber value. Evaluation criterion:

- Estimated volume of timber in host type on lands suitable and available for harvest that would lose value from mortality by not protecting the area.

3. Non-Target Lepidoptera

The Issue: B.t.k. could kill larvae of non-target Lepidoptera. Evaluation criterion:

- Estimated percent of overall decrease in non-target Lepidoptera over time.

4. Maintaining Healthy Forests

The Issues: a) Allow the natural cycle of tussock moth to thin out Douglas-fir and true fir trees, thus restoring a “healthy ecosystem”; b) Protect forests from tussock moth because dead or dying trees are a sign of an “unhealthy forest”. Evaluation criteria:

- Estimated number of acres of dry site forest that would have host type reduced by defoliation, specifically where host type trees have become dominant due to fire suppression.
- Estimated acres protected from DFTM-related mortality.

OTHER ISSUES

5. Fuel Build-up and Fire Risk

The Issue: In unprotected areas, additional fuels could increase the risk of ignition and catastrophic fire. Evaluation criterion:

- Estimated number of acres of severely defoliated or dead trees that would significantly increase fire fuels.

6. Effects of Spraying on Fish and Wildlife

The Issue: Wildlife or fish could ingest insecticide. Evaluation criterion:

- Estimate of insecticide toxicity to fish and wildlife (excluding insects).

7. Water Quality

The Issues: a) Defoliation of unprotected riparian areas could affect stream temperature, peak flows, sediment input, etc.; b) The insecticide could pollute streams and lakes. Evaluation criteria:

- Estimated potential for increased stream temperature. Number of stream miles in 60 – 100% host type not protected as an indication of potential stream temperature increase.
- Estimated potential for increased sedimentation.
- Estimated potential for increased nitrogen from tree needle decomposition and insect frass.

- Risk of adverse effect of B.t.k. or TM BioControl on water quality that could result in problems to fish, animals, or humans.

8. Economic Effects from Decreased Tourism

The Issue: Protection of recreation areas could help local communities by maintaining tourist and recreation income. Evaluation criterion:

- Estimated loss of revenues to local communities because of degraded recreation areas.

9. Tussock moth larvae could increase the food supply for wildlife species

The Issue: Killing tussock moth larvae could reduce the opportunity for certain wildlife to take advantage of a food surplus. Evaluation criterion:

- Estimated tussock moth population reductions.

10. Operations

The Issue: Spraying could cause environmental problems or limit access to the forest during operations. Examples include fuel spills, helicopter crashes, noise, and road closures during operations. Evaluation criterion:

- Estimated potential for spills and accidents.

11. Secondary Mortality

The Issue: Weakened trees that survive the tussock moth infestation could die from secondary attacks by bark beetles or other forest pathogens. Evaluation criterion:

- Estimated additional increase in percentage of mortality from secondary insects and disease.

SPECIAL MANAGEMENT CONSIDERATIONS

Within the potential tussock moth outbreak area, there are about 1,655,750 acres that contain 20-60% host type (see Glossary) trees and 2,587,000 acres that contain 60-100% host type trees. Of the 4,242,750 total acres being analyzed, not all would be affected. Additionally, the Forest Service is not able to predict exactly which trees will be defoliated. Therefore, the analysis in this document only covers the acres that could be protected should an outbreak occur. ***“Blanket” spraying over all National Forests is NOT proposed under any alternative. Active protection would only occur in areas identified in the selected alternative where tussock moth larvae are at sub-outbreak or outbreak levels.*** Individual populations could reach outbreak levels at different times; thus, treatment could occur anytime between the years 2000 and 2004.

The number of acres that can be treated with TM-BioControl is limited. It would not be possible to produce additional virus for the current outbreak. TM-BioControl was produced at a Forest Service facility in Corvallis, Oregon from 1981 to 1995. It would take 9-10 years to produce this same quantity of new virus for future

outbreaks. This is because of the time required to reestablish the manufacturing facility and to rear sufficient numbers of tussock moths to produce an adequate supply of the virus.

REGULATIONS, DIRECTION, AND POLICIES

This environmental impact statement has been prepared in accordance with regulations established under the National Environmental Policy Act of 1969. Implementation of any alternative will comply with applicable local, State, and federal laws, regulations, or policies.

Resource objectives are established in the land management plans of each of the Forests covered by this document. Contained within these management plans are standards and guidelines for pest management. There are excerpts of these standards and guidelines in Appendix F. For a complete list of standards and guidelines for each Forest, it will be necessary to refer to that Forest's Land and Resource Management Plan.

Resource direction is also provided by the *1994 Final Supplemental Environmental Impact Statement on Management of Habitat for Late Successional and Old Growth Forest Related Species Within the Range of the Northern Spotted Owl and Record of Decision*⁵. Additional objectives are described in the *1995 Decision Notice for the Revised Continuation of Interim Management Direction Establishing Riparian, Ecosystem, and Wildlife Standards for Timber Sales, Regional Forester's Amendment #2*.

Any Forest Service use of an insecticide must comply with the terms of the *Federal Insecticide, Fungicide, and Rodenticide Act of 1972*, as amended. The Forest Service must meet all Environmental Protection Agency air and water quality standards. The EPA is directly responsible for regulating the availability and use of pesticide products. The Forest Service must comply with all terms of the *1973 Endangered Species Act* and ensure that viable populations of sensitive species be maintained and do not become threatened or endangered as a result of Forest Service actions.

The Forest Service uses the Integrated Pest Management ("IPM") approach. This strategy incorporates pest monitoring, prevention, suppression, and evaluation. The intent of the prevention component is to avoid creating ecological conditions that foster pests, or to correct management-created conditions that would allow continued pest problems. The prevention component is implemented through long term management strategies such as those found in the forest management plans.

The suppression component is a short term management action aimed at protecting vegetative conditions and involves selecting a single tactic, concurrent measures, or a sequence of tactics. Suppression can be direct or indirect. Direct suppression methods are usually applied to existing pest populations with the intent of limiting damage to a

tolerable level. Examples of direct suppression include spraying insecticides or releasing parasites or predators. Indirect suppression involves altering conditions that foster pest population growth. Examples include silvicultural activities to reduce stand density or to change the vegetation component. Post-suppression activities involve monitoring to determine the effectiveness and efficiency of the suppression. Effectiveness evaluations are based on the change in net resource value rather than changes in pest population numbers. To improve overall program performance, information gathered during evaluation is fed back into the system, and appropriate adjustments are made to pest management strategies.

The advantage of using an integrated pest management approach is the consideration given to other potential pest problems when analyzing specific situations. The goal is to avoid creating or intensifying one pest problem while attempting to alleviate another. The strength of the IPM philosophy is that it requires pest management be incorporated into the broad arena of forest and range management.

DECISIONS TO BE MADE

This Environmental Impact Statement informs the Pacific Northwest Regional Forester (the Deciding Official) of the direct, indirect, and cumulative effects to the environment of the Proposed Action and all alternatives. This document also informs the public of management proposals and the potential effects on the environment by these actions.

In the Record of Decision, the Regional Forester can decide to:

- 1) Allow DFTM populations to follow a natural course of population buildup and decline on all 4.2 million acres of forested host type identified in this analysis (No Action Alternative).
- 2) Apply B.t.k. and/or TM-BioControl on Areas of Concern where the tussock moth population levels have reached sub-outbreak or outbreak levels within the 628,000 acres evaluated in the Proposed Action. DFTM populations would follow a natural course of population buildup and decline on all other acres of forested host type identified in this analysis (Proposed Action).
- 3) Apply B.t.k. and/or TM-BioControl on all lands where tussock moths have reached sub-outbreak or outbreak levels within the 2.5 million acres evaluated under the Expanded Protection Alternative. DFTM populations would follow a natural course of population buildup and decline on all other acres of forested host type identified in this analysis (Expanded Protection Alternative).
- 4) Apply TM-BioControl only on Areas of Concern where tussock moths have reached sub-outbreak or outbreak levels within the 628,000 acres evaluated under the virus only alternative. DFTM populations

⁵ Also known as the "Northwest Forest Plan"

would follow a natural course of population buildup and decline on all other acres of forested host type identified in this analysis (TM-BioControl Only alternative)

- 5) Modify which areas would be protected in any action alternative. Modify or stipulate which insecticide would be used in specific areas to be protected or under specific conditions or circumstances.

CHAPTER II: ALTERNATIVES, INCLUDING THE PROPOSED ACTION

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SUMMARY OF CHANGES BETWEEN DRAFT AND FINAL

Numbering of alternative was dropped. The alternatives are defined by name only. In the draft, Alternative 1 was the Proposed Action. It is now referred to as the "Proposed Action". In the draft, Alternative 2 was the called "Expansion of Protected Areas". It is now referred to as the "Expanded Protection Alternative". In the draft, Alternative 3 was the No Action Alternative. It is now referred to as the "No Action Alternative" and appears first in all discussions.

Order of alternatives was rearranged to provide smoother transitions.

Provided a more detailed description of each alternative.

A Virus Only Alternative was analyzed in response to public comment (previously listed as considered but not evaluated in detail).

CHAPTER 2. ALTERNATIVES, INCLUDING THE PROPOSED ACTION

2.1.0 ALTERNATIVES

2.1.1 CONSIDERATION OF ALTERNATIVES

2.1.1.1

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2.1.1.6

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2.1.1.8

2.1.1.9

2.1.1.10

2.1.1.11

2.1.1.12

2.1.1.13

2.1.1.14

2.1.1.15

2.1.1.16

2.1.1.17

2.1.1.18

2.1.1.19

2.1.1.20

2.1.1.21

2.1.1.22

2.1.1.23

2.1.1.24

DEVELOPMENT OF ALTERNATIVES

The need for action was based on results of the Douglas-fir Tussock Moth Early Warning Trapping System. A substantial increase in moth populations, toward outbreaks levels, suggested to the Forest Service a need for immediate action. Please refer to Appendix D for more information on the Early Warning Trapping System and tussock moth population sampling.

The analysis was limited to mitigating the impacts of the current outbreak, expected to occur between 2000 and 2004. Because of the immediacy of the outbreak, any action, would need to be implemented beginning in spring, 2000. Once the Purpose and Need had been identified, an interdisciplinary team (IDT) was formed to develop and evaluate various protection alternatives.

The IDT refined the Proposed Action to make it more specific. The IDT also defined potential issues and reviewed public comments, resulting in the creation of alternatives to the Proposed Action. Potential alternatives not selected for further analysis are described in "Alternatives Considered but Eliminated from Detailed Study", page II-6.

Emphasis items or concerns expressed by participants during the scoping phase included:

1. A desire to avoid conditions similar to the outbreak of the early 1970's.
2. Concern that the timber should be included as a resource to be protected.
3. Belief that dispersed recreation areas are also important areas to protect.
4. Need to analyze the health effects on humans from contact with moth larvae and from the insecticide(s).
5. The concept of maintaining "forest health" as defined by allowing the natural cycle to occur and by keeping trees alive.

ALTERNATIVES CONSIDERED IN DETAIL

Four alternatives (a No Action, and three action alternatives) are described below. These alternatives have potential effects across the landscape of each Forest. Please refer to Appendix A for specific information on Forest management allocation areas where activities could occur.

NO ACTION ALTERNATIVE

This alternative is required per 40 CFR 1502.14(d) but was also mentioned in public comment letters. Concerns for a No Action choice included allowing the insect to evolve through its "natural" life cycle without interruption, allowing trees to be naturally defoliated, and known or unknown effects of insecticides.

The No Action Alternative would preclude all tussock moth control activities. Other activities scheduled under other environmental documentation would continue. It would not meet the identified purpose and need.

PROPOSED ACTION

This is essentially the Proposed Action described during public scoping in August 1999. The Forest Service proposes to protect 628,000 acres from defoliation by the Douglas-fir tussock moth on portions of nine national forests. Protection would be by spraying B.t.k. and/or TM-BioControl. Spraying would **only occur where outbreak or sub-outbreak populations of larvae have been verified**. Those areas where defoliation would result in degradation of threatened or endangered fish and wildlife habitats, recreation areas, or other Areas of Concern would be targeted. The biological agents would be applied primarily from the air, although ground application could occur in specific areas such as seed orchards. In unprotected areas, the insect would evolve through its natural life cycle without interruption.

This action is not designed to control the outbreak across the entire host type on the nine National Forests, only to protect specific Areas of Concern within these Forests. This proposal assumes there are adequate resources (insecticide, equipment, funding, etc.) for treatment. This proposal does not consider lands adjacent to National Forests.

Testing or development of new suppression technologies, such as mating disruption, could occur at some experimental sites. Agency personnel would conduct these tests. Other agencies or organizations could be involved in the research.

The Proposed Action would meet the stated goal of maintaining the functionality of current or desired future condition of the identified Areas of Concern. This would be accomplished by protecting Douglas-fir and true firs from defoliation and death. The existing condition of riparian habitats, key habitat areas for specific wildlife species, recreation areas, and other identified Areas of Concern would be maintained.

Two Areas of Concern are in Wilderness:

- Lake Chelan-Sawtooth Wilderness (Okanogan NF): 5,850 acres where defoliation would cause an unacceptable increase of fuels and resultant fire risk to adjacent facilities and private property.
- North Fork Umatilla Wilderness (Umatilla NF): 5,890 acres of anadromous and bull trout habitat, and late/old structure stands where defoliation would result in unacceptable degradation of habitat.

Table II-1: Areas Protected under the Proposed Action and TM-BioControl Alt., in acres

FOREST→	COL	OKA	WEN	UMA	W-W	MAL	OCH	WIN	FRE ⁶	TOTAL
Bark Beetle Protection	0	0	3,260	0	800	3,600	0	0	0	7,660
Fish – Anadromous	0	0	1,230 (18 miles)	27,610 (179 mi.)	6,490 (92 miles)	2,170 (31 mi.)	7,190 (102 mi.)	0	0	0 422 mi.
Fish - Bull Trout	0	270 (4 mi.)	340 (5 mi.)	23,380 (98 mi.)	6,010 (85 mi.)	2,700 (39 mi.)	0	0	190 (3 mi.)	32,890 (234 mi)
Late Succ. Reserves (LSRs)	0	16,600	74,800	0	0	0	0	0	0	91,400
Nesting Hab. Spotted Owl	0	3,000	32,000	0	0	0	0	1,600	0	36,600
Nesting Habitat Bald Eagle	0	0	0	50	0	0	0	0	0	50
Old Growth	0	0	0	18,570	17,660	14,950	55,450	23,100	0	129,730
Late & Old Structure				17,200	83,440	28,860	64,680			194,180
Recreation: high use areas	7,100	1,940	110	3,230	10,940	140	4,200	20	0	27,680
Residential & Admin.	0	120	8,650	940	0	60	240	150	0	10,160
Scenic	0	98,130	4,840	67,270	0	33,630	7,650	0	0	211,520
Seed Orchards	150 (5 Orchards)	420 (2 Orch.)	0	180 (3 Orch.)	360 (6 Orch.)	0	0	0	0	935
Municipal Watershed	0	0	0	12,280	8,740	150	540	0	0	21,710
Other	0	0	610	20	0	14,860	0	1,510	0	17,000
Total⁷	7,260	122,070	93,330	130,310	110,520	72,910	66,680	24,610	190	627,880

⁶ Includes the Demming Creek watershed only.

⁷ The columns do not necessarily add up to the "Total" acres since there is some overlap among Area of Concern categories.

EXPANDED PROTECTION ALTERNATIVE

This alternative proposes to protect 2,505,200 acres from defoliation by the Douglas-fir tussock moth on portions of nine national forests. Protection would be by spraying B.t.k. and/or TM-BioControl. Spraying would **only occur where outbreak or sub-outbreak populations of larvae have been verified**. Areas protected would include the Areas of Concern as described in the Proposed Action, and all other threatened National Forest lands outside Wilderness with 60-100% host type. No additional Wilderness areas would be included that are not already protected in the Proposed Action. The intent of this alternative is to protect all Areas of Concern, and most of the host type acres that could be significantly affected. This action is not designed to control the outbreak across the entire host type on the nine National Forests. The

biological agents would be applied primarily from the air, although ground application could occur in specific areas such as seed orchards. In unprotected areas, the insect would evolve through its natural life cycle without interruption.

Testing or development of new suppression technologies, such as mating disruption, could occur at some experimental sites. Agency personnel would conduct these tests. Other agencies or organizations could be involved in the research.

If implemented, this alternative would exceed the stated purpose and need.

Table II-2: Areas Protected under the Expanded Action Alternative, in acres

FOREST→	COL	OKA	WEN	UMA	W-W	MAL	OCH	WIN	FRE ⁸	TOTAL
Areas of Concern protected in Proposed Action & TM-BioControl Alt.	7,260	122,070	93,330	130,310	110,520	72,910	66,680	24,610	190	627,880
Additional Acres Protected this Alt.	551,190	261,690	31,570	349,530	368,550	260,980	6,570	46,590	660	1,877,330
Total, this Alt.	558,450	383,760	124,900	479,840	479,070	333,890	73,260	71,200	850	2,505,220
Total Acres of 20-60% Host Type Not Protected	621,560	493,170	176,620	931,870	959,700	706,070	112,700	237,350	3,710	4,242,750

⁸ Includes the Demming Creek watershed only.

TM-BIOCONTROL ONLY ALTERNATIVE

This alternative was evaluated in detail following public review of the Draft Environmental Impact Statement, primarily because of possible effects of B.t.k. on non-target Lepidoptera. This alternative would protect the same Areas of Concern as the Proposed Action, but with TM-BioControl only. The current supply of TM-BioControl is probably enough to protect Areas of Concern reaching sub-outbreak / outbreak population levels of the tussock moth, but there is some risk there is not enough. The Forest Service proposes to spray the virus insecticide on a "first come, first served basis" after reserving enough TM-BioControl to protect potential outbreaks in threatened or endangered bull trout and anadromous fish habitat, and spotted owl nesting, roosting, and foraging areas. Later, if it looks like the supply of TM-BioControl will run out, Forest Supervisors will set priorities for protection of the remaining areas. Once the current inventory is exhausted, all active protection would stop. This action is not designed to control the outbreak across the entire host type on the nine National Forests, only to protect specific Areas of Concern within these Forests.

If implemented, this alternative would meet the stated goal of maintaining existing and desired future condition of specific Areas of Concern if the TM-BioControl supply is not exhausted before the outbreak is over. Selection of this alternative will remove the TM-BioControl option as an alternative for other federal land managers because the existing supply would probably be depleted. Please refer to Table II-1, on page II-4 for specific protection areas.

ALTERNATIVES CONSIDERED BUT ELIMINATED FROM DETAILED STUDY

SUPPRESSION OF THE ENTIRE OUTBREAK

This alternative considered protecting all areas of Douglas-fir tussock moth outbreak that could occur on the nine National Forests. This would require protection on over 4.2 million acres, a much larger area than proposed in the other alternatives. In addition to Areas of Concern and 60-100% host type identified in the other alternatives, this alternative would protect all 20-60% host type.

The Douglas-fir tussock moth is a native insect, with an important role in the disturbance ecology of the forests where it occurs. Past management practices and fire suppression have allowed firs to become established in sites that were traditionally pine and larch. This has led to forests with more host trees than historic conditions. Especially in mixed stands of 20-60% host type, Douglas-fir tussock moth acts as a "thinning" agent. The result is less competition for surviving trees, short term increases in nutrients, and new forest openings. This alternative would not facilitate a long-term management strategy of allowing natural disturbances to restore overall ecosystem health.

In addition, the logistics of treating the entire potential outbreak would require a broader, landscape approach to

treatment. This could result in treating many areas that would not need or particularly benefit from, treatment.

SUPPRESSION WITH OTHER INSECTICIDES

This alternative considered using carbaryl, diflubenzuron, or tebufenozide instead of B.t.k. or TM-BioControl. Carbaryl is a relatively broad-spectrum insecticide. Several formulations of carbaryl, such as Sevin-4-Oil™, are registered for use on Douglas-fir tussock moth. Its primary mode of action is through ingestion, although there is also some contact toxicity. Use of this insecticide would be under similar conditions and situations as B.t.k. or TM-BioControl.

The effects of carbaryl are not limited to specific insects. It affects a number of non-target insects and is particularly toxic to honey bees. Although it is commonly used in the human environment as a garden insecticide and on pet flea collars, its overall environmental impact on other insects would be greater than the insecticides proposed for use. Furthermore, State and Federal regulations prohibit carbaryl application near streams and open water. Since protecting trees in riparian areas is one of the primary objectives of this project, using carbaryl would not meet some project needs. Some formulations of carbaryl require mixing with fuel oil as a carrier. Application of fuel oil on the forest environment could have additional impacts.

Diflubenzuron (Dimilin™) prevents the chitin, a protein that is the building block of an insect exoskeleton from depositing properly. As a result, the insect is not able to molt properly due to a lack of chitin in the new cuticle. Exposure may be dermal, but the primary route is through ingestion. Ovicidal effects may also occur (USDA FS and APHIS, 1995). It has been tested in the laboratory (Robertson, 1978) and in field tests against the Douglas-fir tussock moth (Hard, 1978). In most cases, population reduction did not occur for 14 days after treatment, presumably because diflubenzuron is a growth regulator and its lethal action is delayed. When applied shortly after egg hatch, larval populations and damage were significantly reduced (Hard, 1978). Diflubenzuron affects insects, other arthropods, and some fungi. Lepidoptera are the group most severely affected by diflubenzuron, however, it also affects other insects. Effects have been noted on lacewings, ladybird beetles, immature big-eyed bugs, and earwigs, as well as some of the natural parasites and predators of the insects. It affects honeybees, spiders, and mites. Invertebrates of freshwater habitats, especially crustaceans and insects, are subject to population reductions from diflubenzuron (USDA FS and APHIS, 1995). Application near streams and open water would be prohibited.

Use of tebufenozide for control of Douglas-fir tussock moth was authorized by the Environmental Protection Agency after this EIS was initiated. Tebufenozide (Mimic™) is an insecticide that mimics the natural insect molting hormone, eventually causing the larvae to develop an inferior exoskeleton. It must be ingested to be effective. Tebufenozide is considered "reduced-risk" as it

is specific only to Lepidopteran larvae; it does not affect other insects (Rhom and Haas, 1994). Although it has been successfully field tested against the closely related Whitemarked tussock moth (*Orgyia leucostigma*) (Thurston and Kettala, 1998), there is no information indicating tebufenozide has been field tested or used against Douglas-fir tussock moth.

For these reasons, use of carbaryl, diflubenzuron, or tebufenozide for this project was not analyzed in detail.

DOUGLAS-FIR TUSSOCK MOTH MATING DISRUPTION

Since the DFTM female does not fly, her ability to reproduce is dependent on her success in attracting a mate. The female moth produces a pheromone that attracts the male moths and helps them locate her. Mating disruption techniques saturate an area with synthetic pheromone. This confuses male moths, making them unable to locate the real female. The mating disruption of Douglas-fir tussock moth has been effective in experimental field tests. However, several questions must be answered before it can be recommended as an operational control option. These include the maximum size of the treatment area in which this treatment can be effective, the appropriate dose, and the appropriate application and delivery systems. More importantly, the Douglas-fir tussock moth pheromone is not currently registered by EPA for use in controlling tussock moth.

PROTECTION OF AREAS OF CONCERN PLUS SILVICULTURAL TREATMENTS

This alternative proposed control of the expected tussock moth outbreak (as described in the Proposed Action) plus a variety of silvicultural treatments to address potential future outbreaks. Harvest, tree planting, thinning, and prescribed burning, would occur on 300,000 acres in addition to those described in the Proposed Action.

This alternative was eliminated from further consideration because it is beyond the scope of this analysis. Long-term forest management strategies have been addressed in Forest Plans and other documents and in analyses such as the Interior Columbia Basin Ecosystem Management Project ("ICBEMP") now underway. Site-specific analysis for areas identified for silvicultural treatments would be done at the Forest level. Please also see Appendix G for guidelines related to project implementation.

MITIGATION MEASURES

Mitigation Measures are actions taken to avoid, minimize, reduce, or eliminate the impacts of implementing an alternative. The following mitigation measures would apply to all action alternatives:

Apply only TM-BioControl:

- ✓ Anadromous fish and bull trout habitat.
- ✓ Spotted owl activity centers on the Okanogan, Wenatchee, and Winema National Forests.
- ✓ Showy Stickseed and Wenatchee Mountain Checkermallow habitat (specifically, Showy Stickseed

buffer – T25N R17E Sections 13-16, 21-28, 33 - 36; T24N R17E Sections 2-5; Wenatchee Mt. Checkermallow buffer– T23N R18E; T23N R18E Sections 2-6, 7-11; T22N R18E Sections 2-6, 7-11; T23N R17E Sections 3,10,15,22,27,34; T22N R17E Sections 2,3,10,11). These plants are pollinated by Lepidoptera (moths and butterflies).

- ✓ Yellow-cedar grove on the Malheur NF.
- ✓ Research plots (1 mile radius) associated with neotropical bird studies on the Okanogan, Wallowa-Whitman, and Ochoco National Forests.
- ✓ Known Mardon skipper colonies in proposed protection areas in Klamath County, Winema National Forest.
- ✓ Wilderness on the Okanogan and Umatilla National Forests.
- ✓ Areas adjacent to Wilderness.

Avoid treatment:

- 1.75 mile radius around Townsend's Big-Eared bat maternity sites.
- Pacific Northwest Research Natural Areas.
- ½ - 1 mile buffer around active bald eagle nests as defined in specific Forest Plans and the Northern Bald Eagle Pacific Recovery Plan, except near an important, isolated habit on the Umatilla NF.
- 1 mile buffer around active Peregrine falcon nests.

MONITORING

Please refer to Appendix I for information on implementation monitoring (the Monitoring Plan).

FEATURES COMMON TO ALL ACTION ALTERNATIVES

Most spray will be applied by helicopter. Ground application could occur in small, accessible areas such as campgrounds. The insecticide will usually be sprayed as a single application by a helicopter flying 50 – 75' above the tree tops, with an average swath width of about 90'. This would result in only a momentary presence of the aircraft at any location.

The safe and efficient contract application of pesticides by helicopter in mountainous terrain makes small isolated areas impractical for treatment. In order to safely and efficiently meet project objectives, spray blocks could include some areas not specifically identified for protection. Generally, such inclusions are irregularly shaped. Where practical and possible, some of these areas outside identified protection zones will not be sprayed by turning off the spray equipment during application. Feasibility will depend on operational factors such as safety, mapping, and contractor capability to perform.

Conversely, small, isolated areas specifically approved for protection could be excluded from spray block delineation for the same reasons.

In some cases, there may be small parcels of state or private land (less than 160 acres) surrounded by federal lands ("in-holdings") where protection from defoliation would contribute to project objectives. The most likely scenario is adjacent National Forest lands that have been identified for protection in the selected alternative and whose moth populations have reached sub outbreak / outbreak levels. In such cases, the Forest Service could treat those areas if permission of the landowner had been obtained and after meeting state requirements.

MANAGEMENT CONSIDERATIONS REGARDING THE USE OF TM-BIOCONTROL

The USFS is the sole owner registrant, and producer of TM-BioControl. All of the existing product is maintained in the Pacific Northwest Region. However, the intent has always been to make it available to other agencies, such as the Bureau of Land Management, National Park Service, and other National Forest in other Regions. As stated previously, the supply of TM-BioControl is limited. Implementation of any of the action alternatives could deplete the existing supply. Thus, the option to use TM-BioControl by other agencies could be removed.

COMPARISON OF ALTERNATIVES BY OBJECTIVE AND ISSUE

[Editor's Note: the reader is encouraged to now read Chapters 3, Existing Conditions and Chapter 4, Effects Analysis. By familiarizing oneself with that information which includes the derivation of the numbers, the following comparison of alternatives will be more meaningful].

SUMMARY OF ENVIRONMENTAL CONSEQUENCES

Table II-3: Effects Analysis, by Alternative

CRITERIA	NO ACTION ALTERNATIVE	PROPOSED ACTION & TM-BIOCONTROL ONLY ALTERNATIVE	EXPANDED PROTECTION ALTERNATIVE
Measurement Criteria for Objectives			
<i>Miles of T&E fish streams protected / miles of T&E fish 303[d] listed stream segments protected - where defoliation results in unacceptable degradation of occupied habitat especially important spawning and rearing habitat</i>	<p>Anadromous: All Forests = 0 miles</p> <p>Bull Trout: All Forests = 0 miles</p>	<p>Anadromous: Okanogan = 0 Wenatchee = 18 / 4 Umatilla = 179 / 110 W-W = 92 / 40 Malheur = 31 / 23 Ochoco = 102 miles / 30 miles Total = 422 / 207</p> <p>Bull Trout: Colville = 0 Okanogan = 4 / 0 Wenatchee = 5 / 3 Umatilla = 98 / 49 W-W = 85 / 34 Malheur = 39 / 24 Fremont = 3 / 2 Total = 234 / 112</p>	<p>Anadromous: Total = 925 / 334 The additional miles over the Proposed Action would not be in areas where unacceptable degradation would occur</p> <p>Bull Trout: Total = 443 / 162 Same as Anadromous above</p>
<i>Number of spotted owl activity center sites protected - where defoliation results in unacceptable degradation of nesting, roosting, and foraging habitat.</i>	All Forests = 0 sites	<p>Okanogan = 5 Wenatchee = 112 Winema = 2 Total = 119</p>	Same as Proposed Action
<i>Late-Successional Reserve acres protected - (where defoliation could result in unacceptable degradation of late successional habitat) / acres protected for other objectives.</i>	All Forests = 0 acres	<p>Okanogan = 16,600 / 30,900 Wenatchee = 74,800 / 0 Total = 91,400 / 30,900</p>	<p>Okanogan = 16,600 / 18,500 Wenatchee = 74,800 / 19,300 Total = 91,400 / 37,800</p>
<i>Acres of OG or LOS area protected (where defoliation results in substantial degradation of habitat values) / acres protected for other objectives.</i>	All Forests = 0 acres	<p>Colville = 0 / 0 Okanogan = 19,710 / 8,200 Wenatchee = 9,480 / 13,000 Umatilla = 14,640 / 4,000 W-W = 63,210 / 32,800 Malheur = 29,820 / 8,700 Ochoco = 28,530 / 34,400 Winema = 0 / 8700 Total = 165,390 / 109,800</p>	<p>Colville = 0 / 118,000 Okanogan = 19,710 / 52,990 Wenatchee = 9,480 / 17,020 Umatilla = 14,640 / 6,360 W-W = 63,210 / 47,090 Malheur = 29,820 / 114,780 Ochoco = 28,530 / 35,000 Winema = 0 / 32,600 Total = 165,390 / 426,840</p>

CRITERIA	NO ACTION ALTERNATIVE	PROPOSED ACTION & TM-BIOCONTROL ONLY ALTERNATIVE	EXPANDED PROTECTION ALTERNATIVE
<i>Number of residential and administrative sites protected where the presence of the larvae would adversely affect people where they work and live, or would cause unacceptable degradation of the environment in the area</i>	All Forests = 0 sites	Okanogan = 7 Wenatchee = 7 Umatilla = 15 Malheur = 1 Ochoco = 4 Winema = 2 Total = 36	Same as Proposed Action
<i>Number of high use, developed recreation sites protected where the presence of the larvae would adversely affect concentrations of forest visitors, or would cause unacceptable degradation of the environment in those areas</i>	All Forests = 0 sites	Colville = 12 Okanogan = 69 Wenatchee = 27 Umatilla = 31 W-W = 7 Malheur = 16 Ochoco = 10 Total = 172	Same as the Proposed Action
<i>Estimated potential for unacceptable degradation of water quality from increased sedimentation either from defoliation or from increased risk of secondary events such as fire in Municipal Watersheds</i>	There are 5 municipal watersheds. No significant sedimentation from defoliation is expected. Secondary effects include increased risk for fire and sedimentation.	4 watersheds (Baker City, City of Sumpter, Canyon City, Walla Walla) protected from defoliation and subsequent increased risk from fire	Same as the Proposed Action
<i>Estimated acres of scenic foreground protected where defoliation results in significant degradation of designated scenic areas.</i>	All Forests = 0 acres	Okanogan = 21,900 Wenatchee = 2,240 Umatilla = 33,520 Malheur = 16,060 Ochoco = 1,790 Total = 75,510	Additional scenic areas in scenic foreground, scenic middle ground, and scenic background where no significant degradation of scenic values would occur.
<i>Number of orchards protected where an unacceptable loss of investment and seed production would result.</i>	All Forests = 0 orchards	Colville = 5 Okanogan = 2 Umatilla = 3 W-W = 6 Total = 16	Same as the Proposed Action
<i>Number of acres protected from defoliation that are currently being protected from bark beetles</i>	All Forests = 0 acres	Wenatchee = 3,260 Malheur = 3,600 W-W = 800 Total = 7,660	Same as the Proposed Action
Measurement Criteria for Issues			
Estimated potential for humans to come in contact w/larvae.	High	Low	Very low
Estimated potential for humans to be exposed to pesticide.	None	Low	Moderate

CRITERIA	NO ACTION ALTERNATIVE	PROPOSED ACTION & TM-BIOCONTROL ONLY ALTERNATIVE	EXPANDED PROTECTION ALTERNATIVE
Worst case scenario - Estimated volume (in thousands of board feet) of dead timber in host type in areas available for harvest. Please also see Appendix K.	Colville = 105,080 mbf Okanogan = 22,900 Wenatchee = 48,380 Umatilla = 251,000 W-W = 264,580 Malheur = 45,120 Ochoco = 52,530 Winema = 4,490 Fremont = 120 Total = 794,200 Total = 130,000 mbf	Colville = 102,340 mbf Okanogan = 18,820 Wenatchee = 13,840 Umatilla = 200,810 W-W = 209,840 Malheur = 34,340 Ochoco = 8,940 Winema = 3,400 Fremont = 10 Total = 592,340 Total = 100,000 mbf	Colville = 30 mbf Okanogan = insignificant Wenatchee = insignificant Umatilla = 10 W-W = 20 Malheur = insignificant Ochoco = insignificant Winema = insignificant Fremont = insignificant Total = 100 Total = 100 mbf
A scenario based on experience from the 1972/73 outbreak as applied only to areas available for harvest.	Low	TM BioControl Alt. - Low Proposed Action Alt. - Mod.	High
Dry site acres of dense high risk host type that could be defoliated	Colville/Okanogan/Wenatchee 84,000 Acres Umatilla/W-W/Malheur/Ochoco 308,100 Acres Winema/Fremont Small amount	Colville/Okanogan/Wenatchee 65,600 Acres Umatilla/W-W/Malheur/Ochoco 210,800 Acres Winema/Fremont Small amount	All Forests = 0 acres
Dry site acres protected Note: In all action alternatives, Areas of Concern are protected to meet the purpose and need objectives. The protection in the Expanded Protection Alternative exceeds those objectives.	Colville/Okanogan/Wenatchee 19,000 Acres Umatilla/W-W/Malheur/Ochoco 97,300 Acres Winema/Fremont Small amount	Colville/Okanogan/Wenatchee 19,000 Acres Umatilla/W-W/Malheur/Ochoco 97,300 Acres Winema/Fremont Small amount	Colville/Okanogan/Wenatchee 84,000 Acres Umatilla/W-W/Malheur/Ochoco 308,100 Acres Winema/Fremont Small amount
Estimated acres of mortality, severe, or moderate defoliation that would cause significant increase in fuels for fire	Total = 360,110	Total = 285,670 Areas of Concern would be protected with subsequent prevention of increased fire risk in those areas.	Total = 108,230 Areas of Concern would be protected with subsequent prevention of increased fire risk in those areas.
Estimate of the insecticide(s) toxicity to wildlife (excluding insects) and fish species	No effect	Effects would be minimal or non-existent.	Effects would be minimal or non-existent.

CRITERIA	NO ACTION ALTERNATIVE	PROPOSED ACTION & TM-BIOCONTROL ONLY ALTERNATIVE	EXPANDED PROTECTION ALTERNATIVE
Estimated potential for effects on temperature (<i>Stream miles in 60 – 100% host type not protected</i> as a measurable factor that may contribute to an increase in stream temperature)	<p>Colville = 1,100 miles Okanogan = 740 Wenatchee = 158 Umatilla = 1,440 W-W = 1,280 Malheur = 815 Ochoco = 85 Winema = 80 Fremont = 2 Total = 5,700</p> <p>Increases would not be measurable from defoliation only. For sedimentation, a secondary effect is increased risk towards severe fire with sedimentation as an aftermath.</p>	<p>Colville = 1,085 miles Okanogan = 560 Wenatchee = 80 Umatilla = 1,080 W-W = 1,105 Malheur = 740 Ochoco = 20 Winema = 80 Fremont = 0 Total = 4,750</p> <p>Increases would not be measurable from defoliation only. The secondary effect for fire risk is a little less than the No Action Alternative.</p>	<p>Colville = 35 miles Okanogan = 90 Wenatchee = 15 Umatilla = 340 W-W = 135 Malheur = 65 Ochoco = 10 Winema = 20 Fremont = 0 Total = 710</p> <p>Increases would not be measurable from defoliation only. The secondary effect for fire risk is a significantly less than the No Action Alternative</p>
Estimated potential for effects on sedimentation & Nitrogen			
Estimated loss of revenue to local communities as a result of degraded recreation areas.	<p>Where high use facilities and popular forest areas are located, local communities would expect to experience significant loss of revenue in the short term – and loss of revenue would accrue until replacement trees begin to take form.</p>	<p>High use recreation facilities would be protected preventing most loss of revenue for those local communities. The expanded landscape would not be protected and dispersed recreation opportunity would be reduced. Income opportunity would be available from spray operations.</p> <p>In treatment areas, DFTM populations would return to non-outbreak levels. There would be fewer chances for opportunistic feeding. Wildlife would maintain feeding habits associated with non-outbreak populations.</p>	<p>Both high use recreation facilities and expanded areas in host type would be protected. Most all areas of high risk for outbreak would be protected, thus minimizing any reduction of income from recreation. Local income opportunity would be available from spray operations.</p> <p>In treatment areas, DFTM populations would return to non-outbreak levels. There would be fewer chances for opportunistic feeding. Wildlife would maintain feeding habits associated with non-outbreak populations.</p>
Estimated insect population level reductions.	<p>No treatment would occur. Wildlife would be opportunistic by feeding on high levels of insects for one to two years. After population collapse, wildlife would revert to feeding habits associated with non-outbreak populations.</p> <p>There would be no risk of accidents or spills related to spraying.</p>	<p>This alternative would have fewer risks than Expanded Protection Alternative due to the size of the areas being treated.</p>	<p>This alternative poses the highest risk for spills or accidents due to the size of the areas being treated.</p>
Estimated potential risk for spills and accidents.			
Estimated secondary mortality that could occur from infestations from bark beetles.	<p>Estimate 6 to 43 % secondary mortality on defoliated acres on 4.3 million acres.</p>	<p>Estimate 6 to 43% secondary mortality on defoliated acres on 3.8 million acres.</p>	<p>Estimate 6 to 43 % secondary mortality on defoliated acres on 1.8 million acres.</p>

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SUMMARY OF CHANGES BETWEEN DRAFT AND FINAL

Separated Existing Conditions and Effects Analysis into two chapters.

Reorganized discussion of existing conditions to provide more detailed information in a clearer format.

Organized most resource categories to correspond to project objectives.

Included more information on fish and wildlife species.

More prominently displayed information on the role of tussock moth in the natural environment.

INTRODUCTION

This chapter describes the existing condition of the environment and provides a baseline for comparison of alternatives. It describes the resources that could be affected by implementation of any alternative. Where possible, these resources are organized to reflect project objectives.



The subalpine fir series is found at higher elevations throughout eastern Washington and Oregon (Franklin and Dyrness, 1973; Omernik and Gallant, 1986). It can be found as low as 3000' on north facing slopes in cool valleys, or in avalanche chutes. It is the dominant series above 4800'. Douglas-fir tussock moth can damage these stands, but rarely causes extensive mortality.

FOREST HEALTH

OVERVIEW

Mountainous regions of eastern Oregon and Washington are dominated by coniferous forests. These forests can be described by *series*, related plant associations named after the dominant climax conifer. Four series provide habitat for tussock moth: Douglas-fir, grand fir/white fir, red fir and subalpine fir.

The grand fir/white fir series is the most extensive, occupying mid-slopes east of the Cascade crest. In eastern Washington, it ranges in elevation from 1800 – 5100' on the Wenatchee National Forest and from 2200 – 4900' on the Colville. It is rare on the Okanogan. In the Blue Mountains of eastern Oregon, it ranges from 2100 – 5900', and in southeast Oregon from 1400 – 5400'.

The Douglas-fir series is less extensive but occurs in a broader elevation range. In eastern Washington, it can be found from 1400 – 5400' on the Wenatchee Forest and in the Methow Valley of the Okanogan, from 2200 – 5400' in the Okanogan Highlands, and from 1900 – 6000' on the Colville. It is fragmented in the Blue Mountains and absent from southeast Oregon.

Both grand fir/white fir and Douglas-fir series can be found on dry to moist sites. On dry sites, the most common early successional tree species is ponderosa pine. At higher elevations, on more moist sites, western larch is the common early successional species, especially on north-facing slopes. Fire suppression during the last century has caused shifts in stand structure, density, and species composition on these sites. Wickman and others (1993) found 75% of these stands are no longer dominated by pine or larch; rather, these stands now consist of large numbers of smaller, climax tree species (i.e. Douglas-fir and other firs). Today, a typical stand in dry or mesic grand fir and Douglas-fir plant associations has a few large overstory pine or larch with a moderately to extremely dense, multi-storied understory of grand fir or Douglas-fir. This has been documented by Hessburg, et. al., in the Interior Columbia Basin Ecosystem Management Project's Eastside Forest Ecosystem Health Assessment, 1994.

The red fir series is found between 5,400 and 7,500 feet elevation from Lake County, California north to Crater Lake. At lower elevations, the red fir series intermingles with white fir series. It can reproduce abundantly after disturbance or under a canopy, and often develops dense, overstocked stands (Eyre, 1980).

Following a major disturbance, reestablishment and development of forest vegetation occurs in stages. For this analysis, Oliver and Larson's 1990 text on stand dynamics was used to categorize the stages. There are four stages: stand initiation, stem exclusion, understory re-initiation, and old growth. The stand initiation stage contains smaller trees that have not fully occupied the available growing space. During stem exclusion, all growing space for trees is occupied and understory trees cannot develop. At understory re-initiation, small gaps in the overstory allow understory trees to develop, creating a multi-storied stand. The old growth stage is reached when, in the absence of major disturbance, all trees that became established after the last major disturbance have died, and trees that developed during understory re-initiation occupy the site.

RISK TO DEFOLIATION AND MORTALITY

Throughout this analysis, there are references to "risk". Research has found that certain stand and site characteristics describe areas most susceptible to a DFTM outbreak and where impacts could be the greatest. Rather than assume the same infestation levels, damage, and mortality would occur across the entire analysis area, and thus overestimate the extent and amount of damage, a set of general hazard/risk rating rules were developed. Appendix K describes these risk rating rules in detail. In general, levels of risk are described as:

High-risk – Dense, multi-storied stands with 60-100% host type trees greater than 9" in diameter. Stands occur on drier south, southeast, or southwest facing mid-elevation slopes and ridges.

Moderate Risk – Single or multi-storied stands with at least 20% host type trees greater than 9" in diameter; any slope aspect at mid- to lower elevations.

Low Risk – Stands of mostly smaller trees (less than 9" in diameter) that have not fully occupied the available growing space; 20% host type; < 40% crown closure; any aspect at high elevations.

High-risk sites are in the stem exclusion, understory re-initiation, or the old growth stage. Moderate-risk sites are in either the understory re-initiation or the stem exclusion stage. Low-risk sites at high elevations can be in any successional stage. Below 4500' in Washington or 8000' in Oregon, low risk sites are in the stand initiation stage.

The nine National Forests where tussock moth outbreak may occur are located in three geographic regions. The Colville, Okanogan, and Wenatchee Forests of eastern

Washington cover the region north of the Yakima River to the Canadian border. The Umatilla, Wallowa-Whitman, Malheur, and Ochoco Forests of eastern Oregon extend from the Washington/Idaho border south to Burns and west to Bend. The Winema and Fremont Forests of southern Oregon cover the area from Fort Rock Valley south to the California border.

There are 5,006,000 acres of National Forest land in eastern Washington. About 20% are 60-100% host type. Host type occurs in both the grand fir and the Douglas-fir series on the Colville and Wenatchee Forests. Host type on the Okanogan is predominantly in the Douglas-fir series. About 84,000 acres are considered at high risk for defoliation. These are multi-storied stands with little remnant pine or larch and many sizes of grand fir or Douglas-fir. Dwarf mistletoe and root disease are common in high-risk Douglas-fir.

There are 6,148,000 acres of National Forest land in eastern Oregon. A little less than one-quarter of these acres are 60-100% host type and of this, 493,000 acres are considered high risk for tussock moth outbreak. The grand fir series dominates but it includes a substantial component of Douglas-fir.

Southern Oregon has 2,200,000 acres of National Forest land. Only a small portion is 60-100% host type, mostly multi-storied stands of true fir and ponderosa pine. Most stands have less than 70% crown closure, and are considered moderate to low risk for defoliation. There is no history of major outbreak (Mason, 1996). Overstocking is common, particularly in the Chiloquin Ridge area and in the southernmost Late Successional Reserve.

The assessment of risk was used to describe existing conditions and to help determine potential effects. Risk was NOT used to prioritize areas or eliminate them from the analysis. It cannot be assumed that DFTM would only occur in the high to moderate risk areas. Table III-1, below, shows the number of acres of host type on each Forest by percent host type and risk category.

In addition to risk from the tussock moth, there is a risk of additional mortality from bark beetles or other forest pathogens. In general, bark beetles are opportunistic and prefer stressed and weakened trees. Douglas-fir beetle, *Dendroctonus pseudotsugae* Hopkins, and the fir engraver, *Scolytus ventralis* LeConte are the major bark beetles of Douglas-fir and true firs, respectively. Stands defoliated by Douglas-fir tussock moth can be killed by defoliation or by bark beetles. The amount of mortality is influenced by defoliation, the environmental conditions preceding and during the outbreak, and bark beetle activity already in the area (Berryman and Wright, 1978; Wickman, 1979). For instance, areas that experienced drought in the previous year or have an ongoing bark beetle outbreak would have higher losses from bark beetles in conjunction with the outbreak than areas where bark beetles were not active. Beetle populations build up in the weakened trees, then attack defoliated and more resistant trees in subsequent years (Berryman and Wright, 1978; Weatherby, et. al 1997). Bark beetle mortality begins during peak years of defoliation and can continue for up to four years after a tussock moth population collapses.

Table III-1: Host Type Acres by Risk

Forest	Host Type	High-risk	Mod.-risk	Low-risk	Total
Colville	60-100%	52,510	87,180	442,560	582,250
	20-60	0	5,880	33,430	39,310
Okanogan	60-100	17,220	101,950	254,450	373,620
	20-60	0	51,270	68,280	119,550
Wenatchee	60-100	14,330	43,330	20,320	77,980
	20-60	0	74,800	23,840	98,640
Umatilla	60-100	270,680	325,500	10,120	606,300
	20-60	10,390	272,020	43,160	325,570
W-W	60-100	188,690	297,610	11,960	498,260
	20-60	54,570	308,000	98,870	461,440
Malheur	60-100	24,170	259,280	53,000	336,450
	20-60	0	172,950	196,670	369,620
Ochoco	60-100	8,850	22,560	10,370	41,780
	20-60	0	43,660	27,260	70,920
Winema	60-100	19,990	29,430	19,610	69,030
	20-60	0	86,660	81,660	168,320
Fremont	60-100	100	770	500	1370
	20-60	0	750	1590	2340
TOTAL		661,500	2,183,600	1,397,650	4,242,750

Mortality from defoliation alone is similar for both Douglas-fir and true fir. Douglas-fir suffers higher amounts of overall mortality because it has higher levels of defoliation and because it has a higher secondary mortality from bark beetles. Wickman (1978) found that if a stand contained more than 50% Douglas-fir, the percent of stand mortality more than doubled. In Douglas-fir stands, mortality from defoliation also was concentrated in the smaller trees and mortality from bark beetles in the larger trees. Fir engraver beetles will cause mortality in all size classes of true fir, while Douglas-fir beetles prefer larger dominant and co-dominant trees (12" – 36" dbh). There are a number of areas throughout eastern Washington and Oregon that currently have elevated Douglas-fir beetle populations because of wind throw, fires, and other environmental factors.

COLVILLE NATIONAL FOREST

Douglas-fir beetles have been causing mortality in large Douglas-fir on 1,000 acres per year since 1997. Mortality is concentrated on the east side of the Forest. Fir engraver has also been reported, with noticeable mortality in grand fir on 700 acres per year since 1997. Western balsam beetle caused subalpine fir mortality on 1,200 acres in 1997; damage declined to 200 new acres in 1998. Stands at high risk for DFTM defoliation are mostly on the eastern half of the Forest, particularly the Sullivan Lake and Newport Ranger Districts.

OKANOGAN NATIONAL FOREST

Douglas-fir beetle activity has increased over the last two years. Mapped on 400 acres in 1997, it had spread to over 1,000 acres in 1998. Fir engraver and western balsam bark beetle have caused subalpine fir mortality on 2,000 acres in both 1997 and 1998. High-risk stands are mostly on the Methow Valley Ranger District, along the Twisp River and Eightmile and Granite Creeks.

WENATCHEE NATIONAL FOREST

Douglas-fir beetle has increased over the last two years. It was mapped on 1,000 acres in 1997 and on over 2,500 acres in 1998. Fir engraver has also caused mortality in grand fir: 4,000 acres in 1997, 1,400 acres in 1998. Western balsam bark beetle activity in subalpine fir was mapped at 900 acres each year, in 1997 and 1998. Stands at high risk for defoliation are mostly on the north end of the Forest, along the Entiat River and in the Lake Chelan National Recreation Area.

UMATILLA NATIONAL FOREST

Host type is predominantly grand fir and white fir, but with a substantial Douglas-fir component. Douglas-fir beetle has been increasing on the Forest, with mortality observed on 1,200 acres in 1997 and 4,200 acres in 1998. Fir engraver mortality has recently declines, from 4,700 acres in 1997 to 400 new acres in 1998. Stands at high risk for defoliation are concentrated in the north half of the Forest and around Kelsay Creek, Bowman Spring, and on the Heppner Ranger District.

WALLOWA-WHITMAN NATIONAL FOREST

Host type is predominantly grand fir and white fir, but with a substantial Douglas-fir component. Douglas-fir beetle has been increasing, with mortality of 500 acres in 1997 and 7,300 acres in 1998. In the last two years, fir engraver mortality decreased, with 1,800 acres affected in 1997 and 400 new acres in 1998. A small amount of western balsam beetle mortality in subalpine fir was observed in 1997, but none in 1998. High-risk stands are concentrated in the areas of Horse Ridge, Summit Spring Ridge, along the north end of the Minam River in the Eagle Cap Wilderness, Kuhn Ridge, and Hells Canyon Rim on both sides of the Wilderness boundary.

MALHEUR NATIONAL FOREST

Host type is dominated by grand fir and white fir, but with a substantial component of Douglas-fir. Bark beetles have been active on the Forest in the last two years. Mortality from Douglas-fir beetle was observed over 1,100 acres in 1998. Most of this was in small patches, but one patch was over 500 acres in size. In 1997, fir engraver in grand fir was found in over 1500 acres.

OCHOCO NATIONAL FOREST

Host type stands are mostly grand fir and white fir. Fir engraver beetle populations have been building for the past two years. In 1998, about 3,200 acres were affected. Mortality occurred in a few large patches (one of 1,200 acres). This was an increase over 1997, when several small patches totaled 600 acres. High-risk stands are concentrated in the Bridge Creek Wilderness, the Mill Creek Wilderness, and the Lookout Mt. Management Area.

WINEMA NATIONAL FOREST

Of the 1,000,000 acres on the Winema National Forest, nearly 25% provide host type for tussock moth. These stands are all multi-storied, with trees in all size classes, from seedling to large. In the last two years, bark beetle activity has been noted on the southern half of the Forest.

FREMONT NATIONAL FOREST

Overall, forest health is fair to good. Bark beetles have not been active for the last two years. Only the Demming Creek sub-watershed is included in this analysis.

FOREST ENVIRONMENT

LATE SUCCESSIONAL RESERVES ("LSRs")

LSRs were established in the 1994 Northwest Forest Plan. They are managed to protect and enhance conditions of late successional and old-growth forest ecosystems. These areas serve as habitat for late successional and old-growth related species, such as the northern spotted owl. The reserves are designed to maintain a functioning, interacting, late successional and old-growth ecosystem. The LSR assessments identify vegetation that provides biological diversity representing the range of natural variability. The general objective of all treatments is to

restore, protect or promote late successional habitat for the northern spotted owl and other late successional species.

Late successional structure stands east of the Cascades have a variety of forest types. These can be dry, open ponderosa pine sites with frequent natural fire return intervals, mesic sites dominated by mixed conifers such as pine, Douglas-fir and grand fir, or moist sites dominated by grand fir, Pacific silver fir and hemlock. Tussock moth host species are an important component of late/old structure on mesic and moist sites. Decades of fire suppression have resulted in these host species also becoming common on dry sites. Multi-storied stands on mesic and dry sites provide habitat and potential habitat for spotted owl and other old growth dependent species.

LSRs east of the Cascades are divided in to three geographic provinces. The Northeastern Cascades Province includes the west side of the Okanogan National Forest and the north half of the Wenatchee. The Yakima Province includes the southern half of the Wenatchee. The Eastern Oregon Cascades includes the Winema National Forest. Each province includes a number of LSRs and is somewhat different from the others ecologically. The provinces and LSRs included are described below.

EASTERN WASHINGTON CASCADES PROVINCE

There are 21 Late Successional Reserves (LSRs) and Managed Late Successional Reserves (MLSRs) in the Eastern Washington Cascades Province, totaling about 767,700 acres (shown in blue on the following table). Four of these are entirely on the Okanogan National Forest. The Sawtooth LSR is on both the Okanogan and Wenatchee Forests. The other 16 are on the Wenatchee.

LSRs on the Okanogan are described in the 1998 *Assessment of the Northeastern Cascades Late Successional Reserves*. This Assessment describes LSR vegetation in terms of the biophysical environments in which it occurs. About half of the area is in hot dry, warm dry, or warm mesic biophysical environments. Vegetation in these environments has been strongly influenced by fire suppression. Fire suppression has significantly increased fuels and the risk of stand replacement fire. In much of the area, the biophysical environments are densely stocked with multi-storied Douglas-fir at high risk for tussock moth defoliation. There are host type stands throughout 87% of the LSRs except in cold dry, cold mesic, and cold moist biophysical environments.

Okanogan LSRs provide habitat for 56 known late successional terrestrial wildlife species. Management priorities include protection of late successional habitat, protection of existing late successional and old-growth stands, and enhancement of potential late successional habitat. Special emphasis is placed on existing spotted owl nesting, foraging, and roosting habitat.

LSRs and MLSRs on the Wenatchee are described in the 1997 *Forest-Wide Assessment for Late Successional Reserves and Managed Late Successional Areas* and the 1997 *Assessments for Late Successional Reserves and*

Managed Late Successional Areas, Eastern Washington Cascades Province. These assessments describe LSR vegetation in terms of plant communities with similar fire regimes. Vegetation types are moister on the Wenatchee than the Okanogan. Twenty-seven percent of the LSRs are in the dry forest group. Within this group, dense stocking of grand fir and Douglas-fir is common and susceptibility to tussock moth defoliation is high. Overall, host type occurs over 75% of the LSRs. There is little host type in Hunter Mountain, Slide Peak, Lake Wenatchee, Icicle, Camas, or Twin Lake LSRs. All of the other LSRs contain sufficient host type to support a tussock moth outbreak.

YAKIMA PROVINCE

There are 10 Late Successional Reserves and Managed Late Successional Reserves in the Yakima Province on 158,900 acres (shown in yellow on the following table). All of them are on the Wenatchee National Forest. These LSRs are described in the 1997 *Forest-Wide Assessment for Late Successional Reserves and Managed Late Successional Areas* and the 1997 *Assessments for Late Successional Reserves and Managed Late Successional Areas, Yakima Province*. There is little tussock moth host type in Bumping, Upper Nile, or Rattlesnake. The other LSRs contain sufficient host type to support a tussock moth outbreak.

EASTERN OREGON CASCADES PROVINCE

There are eight Northwest Forest Plan Late Successional Reserves on the Winema, identified as RO227 through RO324 (shown in orange in the following table). They include approximately 80,000 acres.

LSRs 227, 228 and 229 are described in the 1995 *Late Successional Reserve Assessment for #R0227 (eastern half), #R0228, and #R0229 on the Klamath Ranger District, Winema National Forest*. This assessment includes descriptions of vegetative conditions and insect and disease risk. In general, partial cutting and fire suppression have altered the species composition of these LSRs, which now have higher stocking and more white fir than was the case prior to 1900. The assessment emphasizes the need to lessen the risk of catastrophic habitat loss through silvicultural treatments and appropriate protection measures.

The largest LSR is #227, about 61% of LSR acres on the Forest. LSR 227 can be divided into an eastern half, on the Winema National Forest and a western side, on the Rogue River National Forest. The two parts of the LSR straddle the Cascade Crest, and are quite different ecologically. The west side has longer growing seasons, greater precipitation, and longer fire return intervals. Tussock moth exists on the west side, but the risk of outbreak in this type of environment is insignificant. This EIS addresses only the eastern side of the LSR, approximately 49,000 acres in size. There is has tussock moth host type (white fir and Douglas-fir) throughout. Most stands are more than 60% host type. About half of the LSR is late/old structure. Substantial host type is also

found in LSRs 228 and 229, totaling 12,100 acres. The other five LSRs have relatively little host type.

Approximately 100 known or suspected species are associated with these late successional habitats. The northern spotted owl and bald eagle are currently the only federally listed terrestrial species known to occur in the Oregon Eastern Cascades LSRs. These two species are management indicators for old-growth in the Winema Land and Resource Management Plan.

There are 53 spotted owl activity centers on the Klamath Ranger District; 27 are in LSRs and 15 in Wilderness.

Table III-2: LSRs in Project Area, in acres

LSR/MLSR	TOTAL ACRES	TOTAL HOST TYPE	HIGH RISK	MODERATE RISK	LOW RISK
Chiwawa	107,162	11,121	1,465	6,059	3,598
Icicle	14,309	24	1	2	21
Lucerne	8,541	3,419	474	2,403	541
Shady Pass	76,253	10,936	2,031	6,043	2,863
Slide Peak	1,658	143	1	71	71
Deadhorse	18,341	5,384	1,043	3,650	690
Hunter Mt.	6,201	1,786	17	1,312	457
Nice	3,130	2,515	148	1,221	1,147
Twisp River	36,396	22,537	1,943	10,784	9,810
Upper Methow	192,052	51,978	4,527	21,793	25,658
Sawtooth (on the Okanogan NF)	51,861	20,321	822	10,676	8,823
Sawtooth (on the Wenatchee)	15,255	293	3	21	269
Little Wenatchee	52,612	36	16	12	8
Boundary Butte	8,753	1,680	24	1,177	480
DM-1	5,581	0	0	0	0
DM-2	1,073	570	23	450	97
DM-3	4,089	951	22	615	314
DM-5	5,271	2,029	303	1,233	493
DM-6	1,546	472	43	342	87
DM-7	9,234	4,308	306	3,431	570
DM-9	15,740	537	51	391	94
Swauk	108,073	29,766	2,137	18,806	8,823
Bumping	15,022	0	0	0	0
Upper Nile	9,209	168	16	75	77
Manastash	104,860	666	63	413	190
Rattlesnake	10,503	796	14	423	358
Teanaway	34,097	28	12	9	7
Tieton	40,084	520	7	238	275
DM-10	24,689	6,426	566	4,463	1,397
DM-11	12,360	2,270	202	1,135	933
DM-12	6,958	2,806	22	2,148	636
DR-14	12,505	0	0	0	0
RO227	49,036	41,873	6,995	21,963	12,915
RO228	2,829	2,251	608	819	824
RO229	9,258	6,974	569	3,605	2,800
RO230	3,014	112	0	50	62
RO231	4,058	3,697	0	1,744	1,953
RO232	7,254	2,614	0	1,181	1,433
RO233	4,311	2,456	0	1,113	1,343
RO234	99	0	0	0	0

They are well distributed across multi-storied white fir and Shasta red fir stands. Spotted owl continuity across the Cascade Crest is likely to remain. Habitat in the Lake of the Woods Basin and Sky Lakes Wilderness is stable; large-scale losses from insects, disease, or fire are not expected. The LSRs at risk from mortality from insects and disease are: RO227 (east half) – 29%; RO228 – 12%; and RO229 – 33%.

OLD-GROWTH/LATE OLD STRUCTURE ("OG/LOS")⁹

From an ecological perspective, "old growth" (OG) describes stands composed entirely of trees that have developed in the absence of any major disturbance such as fire or logging; changes in available growing space have been caused primarily by plant interactions (Oliver and Larson 1990). Stands with younger trees growing upward but still containing some relic trees can be called "transition" old growth. Barring a disturbance, all relic trees eventually die, and the stand consists entirely of trees that grew upward through the deteriorating overstory. These stands are "true" old growth. Using this definition, not all true old growth stands would contain large trees. Forest plans have defined old growth in a variety of ways, but all include some degree of multi-storied structure which includes a component of large overstory trees, large snags, and large down logs. East of the Cascades, these may be open stands dominated by ponderosa pine, or mixed conifer stands dominated by Douglas-fir and true fir. In riparian areas, they may be dominated by Englemann spruce.

During the 1900s, much of the late/old structure eastside forests were logged, with an emphasis on removal of large trees. As a result, the Forest Service has recognized a need to protect remaining late/old forests because of the valuable habitat they provide for many species of plants, animals and fish, and for their value in maintaining high water quality. In 1995, all eastside forests except the Wenatchee were directed to determine the historic range of variability (HRV) of each forest structural stage for any watershed in which a timber sale would be offered ("Eastside Screens"), with particular emphasis on identifying stands having "late/old structure" (LOS), either single- or multi-storied (USDA Forest Service, 1995, "Eastside Screens"). Effects on identified LOS stands are considered with old growth in this analysis.

An important change in many of the OG/LOS forests that remain is the success of fire suppression, which has allowed Douglas-fir and true firs to regenerate abundantly on sites that would otherwise be less densely stocked, with a higher proportion of pine. On some forests, the multi-storied structures that have developed under these conditions are now providing important habitat for old-growth dependent wildlife species. On dry sites, Douglas-fir tends to be susceptible to attack by a variety of insects and diseases, including Douglas-fir tussock moth. These stands provide good habitat for tussock moth, and under outbreak conditions, they are likely to be heavily defoliated. The continuing buildup of natural fuels on these fire-susceptible sites has created conditions where fires burn more intensely and are more difficult to suppress. In this situation, very hot crown fires may result, which can kill overstory trees, taking these late/old forests back to an early successional stage. (Refer to the Fire section of this chapter for a more complete discussion of

fuel buildup and fire risk.) Stands identified as "high risk" with dense crown closure have the highest likelihood of damage if a tussock moth outbreak occurs.

Eastern Washington

About half of the late/old structure in the eastern Washington Forests is tussock moth host type.

COLVILLE NATIONAL FOREST

There are 175,800 acres of late/old structure on the Colville. Most of this is on the west side of the Forest or in the Salmo-Priest Wilderness near the Canada/Idaho border.

OKANOGAN NATIONAL FOREST

There are 184,300 acres of late/old forest on the Okanogan. Most of this is on the north half of the Forest, particularly the upper Methow Valley.

WENATCHEE NATIONAL FOREST

There are 515,100 acres of late/old structure on the Wenatchee National Forest. Most of these acres are not in tussock moth host type. Late/old structures in host type are found mainly in the Late Successional Reserves where they are an important habitat component for spotted owl.

Eastern Oregon

Three quarters of LOS in northeastern Oregon is tussock moth host type.

UMATILLA NATIONAL FOREST

There are over 300,000 acres of late/old structure on the Umatilla. These are scattered, relatively small stands. The largest single stand of old structure is 1,300 acres of host type in the Wenaha-Tucannon Wilderness.

WALLOWA-WHITMAN NATIONAL FOREST

There are 496,000 acres of late/old structure on the Wallowa-Whitman, about one-fifth of the Forest's total land. Most of these acres are in host type. There are some non-host stands in the Eagle Cap Wilderness and near the Powder River.

There are late/old stands throughout the Forest. The only extensive areas on the Wallowa-Whitman where late/old stands are absent are along the Snake River and at high elevations near Eagle Cap. Concentrations of high-risk host type are found along the Minam River in the Eagle Cap Wilderness, Powatka Ridge, and Broady Creek on the northern boundary of Hells Canyon NRA, Big Sheep Creek, Indian Rock, and on the adjacent Nez Pierce National Forest along the Salmon River. Patches of high-risk LOS are found throughout Hells Canyon NRA and the Pine Ranger District. About 21,000 acres on the Pine District received light to moderate defoliation from tussock moth in 1999.

MALHEUR NATIONAL FOREST

There are 275,500 acres of late/old forest on the Malheur. This is about 20% of the Forest's total land. Most of this

⁹ Please see Appendix L for more information on OG/LOS.

structure is in host type. A number of these stands provide unique habitat. These include a remnant stand of Alaska yellow cedar that is surrounded by host type, the Canyon City watershed, the visual corridor along Indian Creek trailhead, Upper Deer Creek watershed, Magone Lake, Vinegar Creek, John Day and Middle Fork John Day headwaters, the Genesis Project Area, Reynolds, Phink/Elk and Wickiup watersheds.

OCHOCO NATIONAL FOREST

There are 83,700 acres of late/old forest on the Ochoco. Most of the late/old structure is on the north half of the forest, and is 60-100% host type. Old structures on the south half (Snow Mountain District) are mostly non-host.

Southern Oregon

One-third of the late/old structure on southeastern Oregon Forests is tussock moth host type. Most of this (238,200 acres) is on the Winema.

WINEMA NATIONAL FOREST

There are 238,200 acres of LOS on the Winema. About 37,400 acres (15%) have 60-100% host type stands, all on the Klamath Ranger District. About 54,200 acres (25%) are mixed stands with a substantial Douglas-fir or true fir component; these are primarily on the Chiloquin Ranger District. The remaining stands dominated mostly by ponderosa pine, with Douglas-fir or true fir as a minor component.

FREMONT NATIONAL FOREST

There are 62,100 acres of late/old structure on the Fremont, and all are dominated by ponderosa pine.

FIRE

OVERVIEW

Fire is a major disturbance that produces vegetation changes in ecosystems. It has been present in the coniferous forests of eastern Washington and Oregon for centuries (Agee, 1993 and 1994). Fire is probably responsible for the distribution, composition, structure, and health of the ponderosa pine, Douglas-fir, and true fir plant communities. Historically, fire maintained ponderosa pine throughout its range at lower elevations and killed invading Douglas-fir and true firs (Spurr and Barnes, 1980). Many ecosystems were maintained by fire; life for many forest species literally begins and ends with fire. Management policies that exclude fire lead to changes in forest species succession and disturbance processes. Fire exclusion has created more severe disturbance regimes than those to which native plant and animal species are adapted. Current fire regimes are generally less frequent but with more severe effects than fires in natural ecosystems.

Changes in vegetation type, structure, and composition have had a profound effect on fire regimes in forested areas over the past 100 years (Hann, et. al., 1997). Some of the more significant changes include:

- declines in area and increasing fragmentation of pine forests
- an increase in shade-tolerant, climax fir forests
- more homogeneous forest composition and stand type (Quigley and others, 1996).

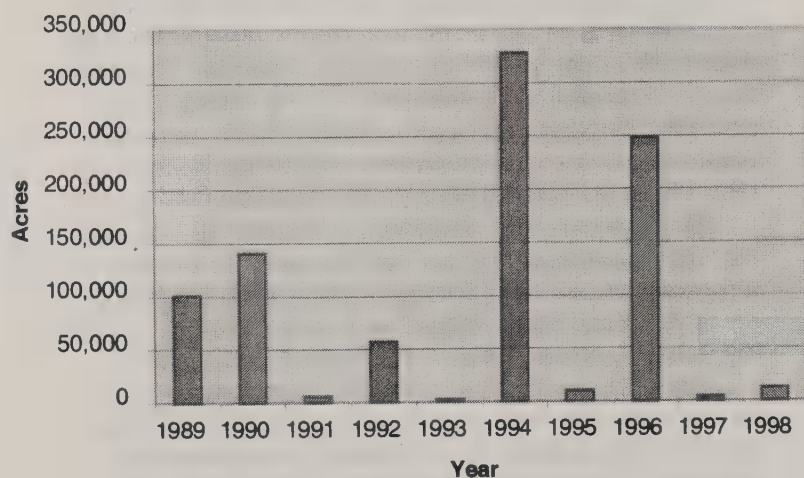
Agee (1993) studied wildfires in Pacific Northwest forests from 1916 through 1992 and concluded that size and extent was correlated to the advancement of fire suppression technology and fuel accumulations. In the early 1900s, fire intervals were generally synchronized with fuel accumulations. Since then, the volume of fuel has steadily increased because of suppression efforts and a subsequent decline in fire frequency. As a result, fire size, fire intensity, and fire severity have all increased, as have suppression costs and the associated hazards to life and property. The average costs of wildfire suppression, number of firefighter fatalities, and size of high-intensity fires during the last 25 years are double the corresponding levels that occurred between 1910 and 1970 (Hann, et. al., 1997).

Wildfire-suppression activities, aided by improved technology for fire detection, prevention, and suppression, successfully reduced the size of most wildfires from 1910 to 1970 (Hann, et al., 1997). Recently, the area burned by wildfires has increased, even though land managers have allocated more resources to wildfire suppression. The current size of wildfires is now approaching that experienced in the early 1900s. Further complicating wildland fire management is that the human population in wildland areas has increased substantially in the last few decades. Unfortunately, the most popular areas are often associated with the highest fire danger. Resultant concerns include simultaneously providing for the safety of people, protection of homes, firefighter safety, and the cost of fire suppression. Fires that impacted both natural resources and populations include the 1994 Tyee Creek Fire in eastern Washington (140,000 acres) and the 1990 Pine Springs Basin Fire in south-central Oregon (73,000 acres). The chart below illustrates the large, but variable extent of wildfire in eastern Washington and Oregon over the last ten-years.

Only recently has fire policy been modified to recognize the importance of fire as an ecological process that has an important role in the management and restoration of ecosystems. The 1995 USDI and USDA *Federal Wildland Fire Management Policy and Program Review* recommended a set of consistent policies for all federal wildland fire management agencies. It recognized that wildfire has historically been a major process maintaining healthy wildlands and that it must be allowed to continue this natural role wherever possible. The report also recognized that not all agencies would employ all identified procedures on all administrative units at all times (USDI and USDA, 1996).

The severe wildfire seasons in northern California and southwest Oregon in 1987, in Yellowstone Park and the

Acres Burned by Fires 100 Acres or Larger
1989-1998



northern Rocky Mountains in 1988, and throughout much of the west in 1994 and 1996, made it clear that fire cannot be effectively excluded from fire-dependent ecosystems. Conversely, because of development in the wildland/urban interface, commercial forests, and widespread fuel accumulations, fire cannot be fully restored to its historic role.

FIRE FREQUENCY AND SEVERITY

Fires can be described by their effects on vegetation and how often these effects occur. Severity refers to the amount of damage a fire actually causes; the return interval refers to how often a particular type of fire occurs. There are 4 severity classes and 5 interval classes (Agee, 1993):

1. Lethal (kills the dominant layer of plants)
 2. Mixed (mixed effects)
 3. Non-lethal (does not kill the dominant layer of plants)
 4. Rarely burns
- A. Very frequent interval (0 - 25 years)
 - B. Frequent (26 - 75 years)
 - C. Infrequent (76 - 150 years)
 - D. Very infrequent (151 - 300 years)
 - E. Extremely infrequent (> 300 years)

Non-Lethal Fires kill 10% or less of the dominant tree canopy. A much larger percentage of small understory trees, shrubs, and forbs may be burned back to the ground line. These are commonly low severity surface and understory fires, often with very frequent return intervals.

Mixed Severity Fires kill 10 - 90% of the dominant tree canopy. These fires are commonly patchy, irregular burns, producing a mosaic of different burn severities. Return intervals are variable.

Lethal Fires kill 90% or more of the dominant tree canopy. These are often called stand-replacing fires and they often

burn with high severity. They are commonly crown fires. In general, lethal fires have long very infrequent return intervals but affect large areas.

Historically, eastern Washington and Oregon had a variable fire regime of long-interval, large, lethal fires mixed with shorter-interval, non-lethal, and mixed severity fires. There is little similarity, however, between historical and current succession/disturbance regimes on forested lands in these states. With few exceptions, disturbance frequency declines as disturbance severity increases. Recent changes in vegetation composition and structure of forests and rangelands have substantially increased the risks of wildland fires at both the landscape and regional levels. These changes to western warm dry forests have been well documented. With effective exclusion of under-burning in this century, warm dry forests have become over-stocked, often exceeding carrying capacity. In the absence of fire, native insects and pathogens play a more active role in regulating stocking. Previously, frequent under-burning prevented excess accumulation of carbon and nutrients in woody biomass. The natural balance between fire and biological decomposition in regulating carbon accumulations has been disrupted. The danger of stand-replacing wildfire is that fuel accumulations get so high that fires are extremely hot. The result can be a critical reduction of stored nutrients and loss of potential site productivity. Effective fire prevention and suppression activities have led to increased ground fuel accumulations and stratified fuels (both living and dead) to the point where fires became more difficult to contain or confine. These fires burn hotter and more extensively than they did in the past. This affect has been especially evident in dry forests that historically burned frequently (Harvey, 1994).

In the past 100 years, fires have become less frequent and more intense (Agee, 1993; Gast, et. al., 1991 in Lehmkuhl, et. al., 1994). In forestlands, fire severity has shifted substantially from non-lethal to lethal between the historical and recent past on Forest Service and BLM-administered lands (Quigley and others, 1996).

Lack of frequent, non-lethal underburns has resulted in:

- ▶ an increase in fuel loading,
- ▶ an increase in duff depth (up to 6B24 inches under old trees)
- ▶ an increase in stand density (generally development of dense conifer understories beneath old stands and thickets of small trees where the overstory has been removed)
- ▶ a fuel ladder that can carry fire from the surface into the tree crowns.

In general, the exclusion of fire and extensive harvesting of large, shade-intolerant trees has resulted in a shift of forest dominance to smaller, shade-tolerant trees that are more susceptible to stress, insects, and diseases.

In dry forest types, stand structures have changed from open park-like stands of large trees with clumps of small trees, to dense overstocked young stands with several canopy layers (Caraher, et al., 1992; Gast, et. al., 1991). The interval between fires has doubled or tripled to 40 to 80 years. Increasing the intervals without corresponding fuel reductions has resulted in much higher fuel loads and much higher fire intensities than were previously experienced. In general, the natural fire regime of the dry forest types consisted of approximately 80% non-lethal underburning fires, 5% mixed fires, and 15% crown fires. Crown fires tended to occur most frequently on steeper slopes. Current fire regimes within the dry forest types comprise 20% lethal crown fires, 35% mixed fires, and 45% non-lethal underburns (Hann, et al., 1997). With the exclusion of fire, stand densities has increased and species composition has changed to dominance by DFTM host types (i.e., Douglas-fir, grand fir, and white fir). The younger forest structure and multi-storied structure of more shade-tolerant species is highly susceptible to large-scale infestations of insects and disease. The increasing number of small dead trees in stands attacked by insects and diseases makes forests even more susceptible to large high-intensity fires. The stands most susceptible to moisture stress, insects, and disease tend to be those at the lowest elevations, often bordering private homes and other property (Everett, et. al., 1994).

Moist forests tend to be located in an environment that rapidly produces biomass and accumulates fuels. Forest succession, an increase in lethal stand-replacing fires, and an increase in human disturbances have changed the structure and composition of vegetation within moist forests. Because fires in moist forests were less common than in dry forests, the effects of fire exclusion on forest structure and composition are not as obvious in moist forests. Major changes to the moist forest potential vegetation group include increased stand density and increased dominance by even-aged shade-tolerant species. Landscapes are now dominated by shade-tolerant species, or a mixture of shade-tolerant and intolerant species, particularly in areas that have been harvested and fire suppression has been successful. The effective exclusion of almost all non-lethal underburns and a reduction of mixed fires have resulted in the development of dense multi-storied stands with high potential for stand-replacing fires. These highly productive forests have increased amounts of carbon and nutrients stored in woody material, resulting in fires that are of higher intensity and severity. Even where fires do not crown, dominant trees can be killed by consumption of large diameter surface fuels and duff layers. Potential for high amounts of soil heating and death of tree roots and other understory plants is much higher than it was historically. The current fire regime has become very simplified compared to the historical regime. Because of higher fuel loads, increased stocking levels of trees, and high late summer moisture stress levels, most of moist forest types shifted to lethal crown fire or mixed fire regimes. In contrast with warm, dry forests, biological decomposition in warm moist forests is substantial and the

role of fire in nutrient cycling is reduced. Conversion of tall, well-spaced pine stands to low densely stratified Douglas-fir and true fir stands results in hazardous fuel ladders.



Figure III-1: Open park-like appearance of non-host stand

Transition forests (warm, dry to warm, moist) possess most of the features of both dry and moist forests. Landscapes were historically a complex patchwork of stands that resulted from lethal and non-lethal fires. Due primarily to the influences of fire exclusion and selective logging, modern day forests are far more homogenous than historical forests. Loss of landscape diversity is primarily associated with increasing dominance and layering of shade-tolerant species in stands previously dominated by open-growing ponderosa pine or other seral species. On areas that transition to moist forest types, the historic forest species composition was mixed with pine and larch playing a more dominant role than that of today. Due to the changes discussed in the previous paragraphs, mixed severity fires are now an improbable occurrence in many transition forests (Harvey, et. al., 1995; USDA 1999).

With large fuel accumulations and dense stocking, levels of root disease and other pathogens can be substantial and increasing accumulations of dead Douglas-fir and true fir associated may be expected. Additionally, conversion of tall well-spaced trees to shorter, denser fir stands results in hazardous fuel ladders. Thus, significant changes in fire behavior are also a characteristic of modern day, moist interior forests. Such changes in fire behavior threaten fire control and place neighboring forest ecosystems at risk (Harvey, 1994).

AIR QUALITY

Wildfires currently have a significant impact on the air resource, degrading ambient air quality and impairing visibility. The wildfire regime is significantly different than it was historically. Fire suppression activities have resulted in altered fire regimes; the area burned in non-lethal understory burns is only one-third of that which burned historically. The results of fire exclusion include increased fuel loading, development of ladder fuels, and increases in stand density, each of which increases the

potential for large, lethal, stand-replacing wildfires such as those experienced in recent years. Stand-replacing fires consume much more fuel and produce much more smoke than non-lethal fires, which usually burn with low surface fire intensities in the understory. Brown and Bradshaw (1994 cited in USDA and USDI, 2000) found that emissions were greater from current fires, even though they burned fewer total acres than historically, because consumption of fuel per unit area burned has been greater in the current period.

Prescribed fires are used to reduce the amount of carrier fuels and ladder fuels, and thus the potential for lethal, stand-replacing fire. The fires are ignited under fuel moisture conditions that reduce total fuel consumption, and when mixing height and winds are most favorable for smoke dispersal away from populated areas.

While increased levels of prescribed fire can have temporary negative impacts on air quality, long-term impacts to air quality from wildfires can be reduced (Schaaf, 1996). Over the past ten years, State air regulators and scientists have that smoke pollution commonly lasts several days. For example, the 1994 wildfires around Wenatchee, WA, produced 24-hour concentrations of smoke that was more than double federal health standards; the condition persisted for several days. Impacts to populated areas from prescribed fires can be more frequent, but the level of impact is well below established health standards (Scire and Tino, 1996 cited in USDA and USDI, 2000).

TIMBER MANAGEMENT

The Forest Plans for the nine Forests considered in this document allocate "management areas" to meet objectives such as "scenic", "motorized or non-motorized recreation", "general forest", etc. Each management area specifies whether planned timber harvest is allowed.

In addition, plans on eight Forests -Colville, Okanogan, Umatilla, Wallowa Whitman, Malheur, Ochoco, Winema, and Fremont (the Wenatchee is excluded)- have been amended by the *Decision Notice for the Revised Continuation of Interim Management Direction Establishing Riparian, Ecosystem, and Wildlife Standards for Timber Sales*; commonly known as the "Eastside Screens" (USDA Forest Service, 1995, "Eastside Screens"). These "screens" have changed the objectives for most timber sales, which, in turn has resulted in a significant reduction in the available volume per acre. For example, timber harvest is not allowed in riparian areas. Timber sales in watersheds that do not currently meet historic levels of "late and old structural characteristics" (LOS) must be designed to develop additional LOS in the area. In watersheds that meet historic LOS levels, timber harvests must maintain LOS within those historic levels.

In similar fashion, Forest Plans on three Forests (the Okanogan NF, Wenatchee, and Winema National Forests) have been amended by the *Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents In the Range of the*

Northern Spotted Owl; commonly known as the "Northwest Forest Plan"(USDA Forest Service, 1994). As with the Eastside Screens, this plan has significantly changed areas from which timber can be harvested as well as the available volume per acre in those areas where harvest is allowed.

Table III-3 displays all acres in host type with commercial size timber (>9" dbh) in Forest Plan land allocations that allow timber harvest. This includes all areas available for harvest in stand sizes of small (9"-14" dbh), medium (14"-21" dbh), and large (>21" dbh) timber. By using a series of continuous inventory plots placed in grid fashion over all National Forests, the Forest Service estimated commercial volume in host type for tree species defoliated by the Douglas-fir tussock moth.

Table III-4 shows volume available for harvest by Forest; volume was calculated on commercial timber 9" or larger.

Table III-3: Acres in Host Type Available for Harvest

FOREST	20-60% HOST TYPE	60-100% HOST TYPE	TOTAL
Colville	33,430	466,780	500,210
Okanogan	45,040	206,660	251,700
Wenatchee	64,050	49,470	113,520
Umatilla	138,810	229,970	368,780
W-W	214,620	250,040	464,660
Malheur	312,300	257,460	569,760
Ochoco	2,810	69,920	72,730
Winema	116,740	11,370	128,110
Fremont* ¹⁰	1,910	760	2,670
Total	929,729	1,542,489	2,472,218

Table III-4: Volume in Host Type Available for Harvest, in thousands of board feet (mbf)

FOREST	20-60% HOST TYPE	60-100% HOST TYPE	TOTAL
Colville	27,700	963,100	990,800
Okanogan	32,600	329,200	361,800
Wenatchee	78,000	132,400	210,400
Umatilla	150,900	661,300	812,200
W-W	232,500	543,300	775,800
Malheur	301,400	563,800	865,200
Ochoco	6,800	377,600	384,400
Winema	108,800	21,200	130,000
Fremont	300	2,200	2,500
Total	939,019	3,594,159	4,533,178

¹⁰ Demming Creek watershed only

SEED ORCHARDS

All National Forests in the Pacific Northwest have orchards to provide seed for reforestation. Orchard trees were grown from open-pollinated seed collected from parent trees that are considered superior in terms of vigor, form, or resistance to local disease. Seedlings from these parent trees show good juvenile survival. Orchards represent considerable investment, including removal of stumps and large rocks, fencing, weed control, and monitoring, and replacement of select trees.

There are 16 orchards in the analysis area that are partially or entirely Douglas-fir:

Colville National Forest: Cedar Creek, Teepee, Brown Mountain, Palmore, Gletty

Okanogan National Forest: Polepick, Peony

Wallowa-Whitman National Forest: Kuhn Ridge, Frog Heaven, Paddy Flat, Forshey, Black Mountain, Yellow Pine

Umatilla National Forest: Mallory, Dugout, Fry



AREAS CURRENTLY PROTECTED FROM BARK BEETLES

In general, bark beetles prefer stressed and weakened trees. When a disturbance, such as a fire or windstorm occurs, the beetles attack damaged trees and produce high numbers of offspring. Subsequent generations attack and kill healthy trees as the supply of stressed trees diminishes. Old-growth stands are highly susceptible to Douglas-fir bark beetle outbreaks because the large, slow-growing trees are often already under stress from competition with other trees and vegetation.

Over the past several years, a number of forest fires and storms have created conditions conducive to a Douglas-fir bark beetle epidemic in parts of the Region. Treatments to minimize impacts on resources have included salvage and removal of infested trees, thinning, and the use of anti-aggregating pheromones and pheromone baits. The primary objective has been to protect existing old-growth, threatened and endangered species habitat, and recreation sites. If a Douglas-fir tussock moth outbreak occurred, the defoliation could result in the tree mortality that the bark beetle projects were attempting to prevent.

Table III-5: Areas Currently Being Treated for Bark Beetles

Forest	Area	Acres	Values being protected
Wenatchee	North 25 Mile Fire	~3,250 acres	Old-growth, and spotted owl habitat in/adjacent to the fire area
Wallowa-Whitman	Pine Creek Watershed	~ 350 acres	Bull trout habitat, old-growth
	Hells Canyon NRA	~ 42 acres	Bull trout habitat, old-growth, campgrounds
	Oregon Trail Interpretive Area	~ 400 acres	Historical Site, old-growth, high use recreation
Malheur	Banner Blowdown	~3,600 acres	Bull trout habitat, old-growth

The table below identifies areas in which investments have been made to manage, treat, or prevent mortality from Douglas-fir bark beetle within the Douglas-fir tussock moth analyses areas:

WATER QUALITY

Substantial areas of eastern Washington and Oregon are subject to defoliation by Douglas-fir tussock moth. The magnitude and distribution of the defoliation would undoubtedly be varied, producing a mosaic of vegetative canopy conditions. During outbreaks in the 1970s, defoliation patterns ranged from partial and small patches to large tracts of 1000 acres.

Water quality concerns associated with defoliation can be grouped into two broad categories: 1) Potential effects that could affect whether water bodies meet State water quality standards and can provide for identified beneficial uses, and 2) Effects on water bodies that do not currently meet State standards. The following table provides a summary of total miles of streams and a summary of stream miles in areas where Douglas-fir tussock moth host type exceeds 60% stand composition. These stands could experience significant (if not total) defoliation and mortality if a DFTM outbreak occurred.

In accordance with *Section 303(d)* of the federal *Clean Water Act*, States must maintain a list of stream segments that do not meet water quality standards. Numerous stream segments in eastern Washington and Oregon are currently listed as *water quality limited*. This means they do not meet State water quality standards for specific water quality criteria. Table III-7 summarizes water quality criteria linked to current *303(d)* listings on each National Forest in the project area that could be affected by defoliation. Six additional criteria are not considered to be substantially or significantly at risk of change as the result of defoliation (State of Oregon DEQ; State of Washington DOE, 1998). Not all water bodies are listed for all variables. Refer to State agency records to identify which particular water bodies are listed for which criteria. The following websites provide a description of the *303(d)* process, variables of concern, and the actual listings each stream:

WA: <http://www.wa.gov/ecology/wq/303d/>;

OR: <http://waterquality.deq.state.or.us/wq/303dlist/>.

Table III-6: Miles of Stream in 60-100% Host Type

FOREST	TOTAL MILES	TOTAL MILES IN HOST TYPE
Colville	1956	1,155
Okanogan	3106	766
Wenatchee	4634	168
Umatilla	2698	1,438
W-W	4678	1,283
Malheur	2930	816
Ochoco	1605	86
Winema	927	80
Fremont	2031	4
Total Miles of Stream	24,565	
Total Miles in Host Type		5796

Table III-8, below, summarizes information relative to the potential for affecting stream temperature, sediment levels, or NH₃. Generally, streams with current water quality concerns and that flow through host types susceptible to significant defoliation are of higher concern than other areas or stream segments. It is important to note that stream segments that are state listed are **not** necessarily impaired along the whole length of the stream or stream segments. The table is only an indication that one or more portions of the stream has not met one of the water quality standards. The miles of stream shown as being listed as water quality impaired (303(d)) are inclusive; that is these miles include both stream segments that are listed in stands of greater than 60% host type and stream segments that are listed in stands of greater than 60% host type. For example, there are a total of 6 miles of stream segments on the Colville NF listed as impaired because of stream

Table III-8: Impaired Streams

FOREST	TEMPERATURE		SEDIMENT		NITROGEN	
	303(D) MILES	303(D) MILES IN >60% HOST TYPE	303(D) MILES	303(D) MILES IN >60% HOST TYPE	303(D) MILES	303(D) MILES IN >60% HOST TYPE
Colville	6	2	0	0	4	1
Okanogan	24	4	0	0	0	0
Wenatchee	197	21	0	0	64	2
Umatilla	446	208	37	25	8	6
W-W	767	141	229	37	0	0
Malheur	501	182	0	0	0	0
Ochoco	440	27	23	2	0	0
Winema	111	16	12	4	0	0
Fremont	354	2	0	0	0	0
Total Miles of Impaired Stream	3,149		301		76	
Total Miles of Stream in Host Type		603		371.6		9

FOREST	IMPAIRMENT CRITERIA		
	TEMPERATURE	SEDIMENT	NITROGEN
Colville	X		X
Okanogan	X		
Wenatchee	X		X
Umatilla	X	X	X
W-W	X	X	
Malheur	X		
Ochoco	X	X	
Winema	X	X	
Fremont	X		

temperature. Of these 6 miles, about two are in an area of greater than 60% host type.

Of all the criteria, temperature is probably the most relevant to this analysis. Temperature "standards" are flexible; there is no specific temperature for each stream or river. The goal of the criteria is to protect fish and aquatic life. It is based on scientific analysis of the needs of cold-water aquatic species. The standard sets the criterion at 64° in Oregon unless there is cold-water fish spawning or bull trout habitat; temperature requirements for these species are 55° and 50°, respectively. In the summer, some streams have probably always exceeded the maximum allowable temperature. The number of such streams is unknown. The standard recognizes that not all streams will be able to comply for this reason. In addition, some stream segments on 303d lists may have been improperly listed and could actually have relatively cold waters.

Table III-7: Summary of Water Quality Criteria

FISH & WILDLIFE

The habitats assessed in this analysis consists of Douglas-fir/white fir, grand fir, and subalpine fir forests on dryer sites at elevations generally from 1500 to 6000 feet in Washington and 2000 to 8000 feet in Oregon. Areas at highest risk of a tussock moth outbreak are lower elevation, multi-storied, Douglas fir, white fir, and grand fir forests with at least 9" diameter trees and more than 40% canopy closure. Subalpine fir forests may experience tussock moth activity, but extensive mortality is not expected to occur.

Many species of wildlife are associated with these habitats on the nine Forests. Federally listed species, sensitive species, management indicator species, and species about which concerns were raised from comment of the Draft Environmental Impact Statement were evaluated. Those included resident and anadromous fish, Larch Mountain salamander, Oregon and Columbia spotted frog, eleven bat species, elk, deer, grizzly bear, gray wolf, goshawk, bald eagle, peregrine falcon, spotted owl, several woodpeckers, four grouse, and 80 - 100 migrant and resident songbirds.

THREATENED & ENDANGERED SPECIES

Table III-9 lists the Federally-listed Threatened and Endangered Species considered in this analysis.

Table III-9: Federally Listed Species¹¹

	COL	OKA	WEN	UMA	W-W	MAL	OCH	WIN	FRE
ENDANGERED SPECIES									
Upper Columbia Steelhead Trout		D	D						
Upper Columbia Spring Chinook Salmon		D	D						
Snake River Sockeye Salmon					D				
Lost River Sucker								D	
Shortnose Sucker								D	D
Gray Wolf	D	D	D						
Woodland Caribou	D								
THREATENED SPECIES									
Mid Columbia Steelhead			D	D	I	D	D		
Snake River Steelhead Trout				D	D				
Snake River Spring/Summer Chinook				D	D				
Snake River Fall Chinook				D	D				
Columbia Chum Salmon				I	I	I			
Columbia River Bull Trout	D	D	D	D	D	D	D		
Klamath River Bull Trout								D	D
Warner Sucker									I
Northern Bald Eagle	D	D	D	D	D	D	D	D	D
Northern Spotted Owl		D	D					D	
Grizzly Bear	D	D	D						
Canada Lynx	D	D	D	D	D	D	S	S	

Anadromous Fish

Five DFTM-project Forests have one or more of the following species of anadromous fish: steelhead trout (*Oncorhynchus mykiss*), chinook salmon (*Oncorhynchus tshawytscha*), sockeye salmon (*Oncorhynchus nerka*), and chum salmon (*Oncorhynchus keta*).

Steelhead are a sea-going ("anadromous") form of rainbow trout. Upper Columbia River steelhead trout are found on the Wenatchee and Okanogan National Forests. It is listed as federally endangered. Mid-Columbia River steelhead occur on the Wenatchee, Umatilla, Malheur, and Ochoco Forests. Snake River steelhead trout live on the Umatilla and Wallowa-Whitman Forests. All are listed as federally threatened.

There are several populations of chinook salmon on Forests within the analysis areas. Upper Columbia River spring chinook salmon occur on the Okanogan and Wenatchee National Forests; they are listed as federally endangered. On the Umatilla and Wallowa-Whitman Forests, Snake River spring/summer and fall chinook populations are listed as federally threatened.

¹¹ D = Documented Occurrence, S = Suspected Occurrence, I = Influenced by USFS Actions Upstream

Sockeye salmon occur in two forms: the anadromous *sockeye* salmon, and the non-anadromous *kokanee*. The only listed population in the analysis area is the Snake River Basin sockeye salmon, on the Wallowa-Whitman National Forest. Populations on the Okanogan and Wenatchee Forests are not on the Endangered Species List.

Chum species have the widest natural geographic and spawning distribution of any Pacific salmonid but do not occur in the analysis area. However, the Umatilla, Wallowa-Whitman, and Malheur Forests contain streams that flow into chum habitat in the Columbia River; activities on these Forests have the potential to affect downstream populations.

All anadromous fish require cool water for some or all of their life stages. Unsuitable temperatures can lead to disease outbreaks in migrating and spawning fish, altered timing of migration, and accelerated or retarded maturation. Most stocks evolved with the temperature patterns of the streams they use for migration and spawning. Deviation from normal patterns could adversely affect survival. Factors that influence stream temperature include air temperature, daily average solar isolation, air velocity, relative humidity, stream depth, ground water inflow, and the extent to which riparian vegetation and topography shade the stream (Adams and Sullivan 1990). The stream temperature at any location in a watershed at a given air temperature is dependent on the relative importance of each environmental condition at the site. Small headwaters streams tend to be cool in summer despite hot weather, due to ground water inflow and riparian shading. In large, wide rivers, neither ground water inflow nor riparian shading is as important due to stream width and total water volume. Even under natural conditions, water temperatures increase with increasing distance from the headwater source. As water moves downstream, stream temperatures become increasingly more influenced by local conditions. Channel morphology can be a significant factor - as width increases and depth decreases, a stream becomes more susceptible to air temperature heating. Removal of riparian vegetation can also result in an increased temperature at the site. Canopy openings from multiple disturbances could increase stream temperature if there was continuous exposure, if the stream widened and/or became shallower, or if water was withdrawn (Adams and Sullivan, 1990).

In spawning areas, the amount and suitability of stream substrate and flows is also critical. Adequate flows of well-oxygenated water and small amounts of fine sediments allow a high percentage of young fish to survive (Meehan, 1991). Flows determine the amount of spawning habitat available by regulating the area covered by water and the velocities and depths of water over the gravel beds. Stream flows can also affect adult migration to spawning areas.

The following describes the current condition of listed anadromous fish within the project area as it relates to the potential for a Douglas-fir tussock moth outbreak. Only host type within 300' of occupied anadromous fish streams

was evaluated. Emphasis was placed on stream segments that are 303d-listed for elevated stream temperature.

OKANOGAN AND WENATCHEE NATIONAL FORESTS

The Okanogan and Wenatchee National Forests are within the Upper Columbia River Inland Steelhead Ecologically Significant Unit ("ESU"); it includes the Wenatchee, Entiat, Methow, and Okanogan River Basins (Busby et al. 1996). On the Wenatchee Forest, "depressed" populations of steelhead are located in the Entiat and Wenatchee River drainages. Other drainages on the Forest are suspected to have steelhead, but reliable information is not available (Quigley et al. 1997). The Okanogan National Forest has depressed populations of steelhead in the Twisp and Chewuch River drainages, tributaries of the Methow River. This Upper Columbia steelhead ESU is in danger of extinction due to with genetic homogenization from hatchery supplementation, apparent high harvest rates of steelhead smolts in rainbow trout fisheries, and the degradation of freshwater habitats, especially the effects of grazing, irrigation diversions, and hydroelectric dams (Busby, et al., 1996). Steelhead on these Forests are federally endangered.

Both Forests are also part of the Upper Columbia River Spring, Summer, and Fall Run Chinook Salmon ESU. The spring run ESU consists of Federally Endangered stream-type chinook salmon that spawn above Rock Island dam, in the Wenatchee, Entiat, and Methow Rivers. Their population has declined in the Methow River drainage. The summer/fall run ESU includes Federally Endangered ocean-type chinook salmon that spawn between McNary and Chief Joseph Dams. On the Wenatchee Forest, there are depressed populations of ocean-type chinook salmon along the lower reaches of the Entiat River, but improving populations in the lower reaches of the Wenatchee. There are also includes declining populations of stream-type chinook in the Naches River, upper reaches of the Yakima River, and upper reaches of the Wenatchee and its tributaries (Chiwawa River, White River, and Little Wenatchee River). Ocean-type chinook salmon do not spawn on the Okanogan National Forest. Unlike the spring run, this summer/fall ESU is not currently in immediate danger of extinction (Myers, et. al., 1998).

Sockeye populations on/near the Wenatchee Forest are part of the Lake Wenatchee ESU. This ESU includes all sockeye that spawn above or in Lake Wenatchee and rear in Lake Wenatchee (Gustafson, et. al., 1997) and sockeye in the Chelan and Wenatchee River drainages. There is a population of landlocked sockeye ("kokanee") salmon in the Naches River drainage. Sockeye salmon that live and spawn in the Methow and Entiat Rivers originated from transplants (Gustafson et al. 1997). Therefore, these populations are not considered part of an evolutionary significant unit.

There are approximately 150 linear miles of occupied anadromous fish streams on the Wenatchee and Okanogan Forests bordered by host type.

UMATILLA AND WALLOWA-WHITMAN FORESTS

Both Forests are in two steelhead ESUs: the Mid-Columbia River and the Snake River Basin. Generally, the southern portion of each Forest is in the Mid-Columbia River ESU and the northern portion is in the Snake River Basin ESU. On the Umatilla National Forest, the Mid-Columbia River Steelhead ESU consists of the upper reaches of the main stem of the John Day River, the lower reaches of Middle Fork John Day River, the upper reaches of the Umatilla River, and the Walla Walla River. The Grande Ronde, Asotin, and Tucannon River drainages are part of the Snake River Basin Steelhead ESU. Of all these drainages, only the uppermost reaches of the Touchet River (Snake River Basin ESU) contain steelhead showing "strong" trends; the rest have declining populations. On the Wallowa-Whitman, the upper reaches of the Umatilla and North Fork John Day River drainages are part of the Mid-Columbia ESU. The upper reaches of the Grande Ronde and Imnaha drainages are part of the Snake River Basin ESU. Both ESUs on the Wallowa-Whitman National Forest consist mostly of "depressed" populations of steelhead. There are no known areas showing "strong" trends for steelhead. All steelhead on both Forests are Federally Threatened. The Snake River Basin Steelhead ESU is not presently in danger of extinction, but it is likely to become endangered in the near future. While total (hatchery + natural) run size has increased since the mid-1970s, there has been a recent, severe decline in the natural run. Most natural stocks in these ESUs, for which data is available, have been declining (Busby, et. al., 1996).

The Umatilla National Forest has no known populations of ocean-type fall chinook, although individuals may be present within National Forest boundaries. Stream-type chinook salmon occur in two ESUs. The Mid-Columbia River Spring Run ESU includes the Klickitat, Deschutes, John Day, and Yakima Rivers. Several tributaries in the southern part of the Forest that originate in the North Fork John Day River contain "depressed" populations. The Snake River Spring/Summer-Run ESU includes populations of spring- and summer-run chinook salmon from the Snake River Basin. On the Umatilla, there are several sites where stream-type chinook salmon populations are depressed: Grande Ronde River (including the Wenaha River drainage), Tucannon River, and Asotin River. The Wallowa-Whitman Forest has widely scattered, depressed populations of stream-type chinook salmon on part of both ESUs. The Mid-Columbia ESU includes the upper reaches of the North Fork John Day and some tributaries. This is the only area on the Wallowa-Whitman with a declining population of spring-run chinook. The Snake River

Spring/Summer ESU includes the upper reaches of the Grande Ronde River and some tributaries, the upper reaches of the Wallowa River, and the Imnaha River. These areas all contain depressed populations of chinook. The Mid-Columbia River Spring Chinook ESU is not presently in danger of extinction nor likely to become extinct in the near future (Myers, et al. 1998). Two major river basins (John Day and Yakima River) are mostly comprised of naturally produced fish and both exhibit long-term increasing trends in abundance (Myers, et. al., 1998). The Snake River Spring/Summer ESU is listed as Federally Threatened.

In addition, the Wallowa-Whitman National Forest borders migratory habitat for Snake River sockeye salmon. This species is listed as federally endangered. There also appears to be a small population of landlocked sockeye salmon on the Wallowa-Whitman National Forest in the upper reaches of the Wallowa River drainage, particularly in the Wallowa River and/or Wallowa Lake.

A portion of the CHU for the Snake River chinook salmon occurs within the Umatilla National Forest. The designated habitat occurs within a 300 foot buffer of the following streams: main stem Tucannon and all tributaries except for Pataha; main stem Asotin and all tributaries except George Creek; main stem Wenaha and all tributaries; main stem Grande Ronde only; Lookingglass Creek and all tributaries. A portion of the CHUs for the Snake River Chinook Salmon and Snake River Sockeye Salmon occur within the Wallowa-Whitman National Forest.



Figure III-2: Landscape Defoliation

This designated habitat occurs within a 300 foot buffer of all the streams within the Forest.

There are more than 280 linear miles of occupied anadromous fish habitat in host type on the Umatilla and 710 miles on the Wallowa-Whitman.

MALHEUR AND OCHOCO NATIONAL FORESTS

The Mid-Columbia River Inland Steelhead ESU includes portions of the Ochoco and Malheur National Forests. Steelhead trout are found only in the northern portion of each Forest, in varying population strength. On the Ochoco Forest, steelhead live in the upper reaches of the Bridge and Rock Creek drainages (John Day River system) and in the upper reaches of the Trout Creek drainage that feeds into the Deschutes River. All the Ochoco steelhead populations are declining. Steelhead also occupy the upper reaches of the main stem of the John Day River, just outside the Malheur Forest boundary. Population in this area has decreased, although the headwaters, which are on

the Forest, show improvement. Canyon and Murderers Creeks, on-Forest tributaries of the John Day, also have strong populations of steelhead. Steelhead in the upper reaches of the Middle Fork of John Day River (on the Malheur Forest) have "depressed" populations; a tributary, Camp Creek, has a steelhead population that is exhibiting strong trends.

Each of these steelhead populations is federally threatened. While the Mid-Columbia steelhead ESU is not presently in danger of extinction, its likelihood of becoming endangered in the near future is unknown. Total steelhead abundance in the ESU appears to have recently increased, but most of the natural stocks for which data is available have declined. This includes those in the John Day River, the largest producer of wild, natural steelhead (Busby et al. 1996).

On the Malheur Forest, there are 200 linear miles of occupied anadromous fish habitat in host type; there are 120 miles on the Ochoco.

Bull Trout (Salvelinus confluentus)

Bull trout are native to western North America. They are non-anadromous and live in a variety of cold-water habitats, including small streams, large rivers, and lakes or reservoirs (cited in Meehan, 1991). Temperature appears to be a limiting factor to many Oregon bull trout populations. Since these populations are in at the southern end of their natural range, they could be threatened by land or water activities that increase temperature (Buchanan, et. al., 1997). Removal of riparian vegetation can cause a local increase in temperature. Bull trout occur on all 9 Forests in the project area and include two distinct population segments ("DPS"): the Columbia River Basin DPS and the Klamath River DPS. Both populations were listed as federally threatened by the U.S Fish and Wildlife Service in 1998. *Occupied bull trout habitat* is defined in this analysis as occupied by bull trout for spawning and rearing, year-round resident use, holding, migrating, or seasonal use. On many Forests, this information is not definitively known; some areas "suspected" to provide the habitat were also included. Only host type within 300' of occupied bull trout streams was evaluated. Emphasis was placed on stream segments that are 303d-listed for elevated stream temperature. The following describes the current condition of bull trout within the project area as it relates to the potential for a Douglas-fir tussock moth outbreak.

Columbia River Basin Distinct Population Segment: The Columbia DPS includes bull trout in portions of Oregon, Washington, Idaho, and Montana. Six of the nine project Forests contain subpopulations of this bull trout population: the Colville, Okanogan, Wenatchee, Umatilla, Wallowa-Whitman, and Malheur. Bull trout are thought to have once occupied 60% of the Columbia River Basin; they now occupy just 4% of that original range (USDI, 1998).

COLVILLE NATIONAL FOREST

Three subpopulations of Columbia River bull trout are estimated to occur on the Colville in Slate Creek, Sullivan Creek, Le Clerc Creek, Mill Creek, and Cedar Creek (Pend Oreille County). None are 303d listed. There is only one known population on the Forest and no verified reds. Only individual sightings of bull trout have been documented. An occasional juvenile has been observed on Le Clerc Creek, a tributary of the Pend Oreille River, since 1993, although the location of their spawning and rearing sites(s) have yet to be found (T. Shuhda, pers. comm., 1999). There are approximately 65 linear miles of bull trout habitat in DFTM host type.

OKANOGAN NATIONAL FOREST

Four subpopulations are known to occur on the Methow Valley Ranger District (USDI, 1998), found in the Beaver Creek, and Chewuch, Lost, and Twisp Rivers, and their tributaries. The Chewuch and Twisp subpopulations are relatively low in abundance. The Lost River subpopulation appears to be healthy and stable. Bull trout in Beaver Creek are the only known subpopulation isolated from the others (B. Baer, pers. comm., 1999). The main limiting factors for Columbia River bull trout within the Methow River watershed are unsuitable habitat caused by water diversions and population isolation. The Twisp and Methow Rivers are the only known bull trout occupied streams that have segments that exceed state requirements for stream temperatures. These stream segments are located off the Forest on private lands. One hundred linear miles of occupied bull trout habitat are in host type.

WENATCHEE NATIONAL FOREST

The Wenatchee National Forest provides habitat for bull trout in three major tributaries of the Columbia River: the Wenatchee, Entiat, and Yakima Rivers (USDI, 1998). Significant spawning activity has been recently observed in White River, a tributary of Lake Wenatchee. Populations are also showing improvement in the Chiwawa Watershed and Rimrock Lake (Tieton River), including both Indian Creek and South Fork Tieton Creek. Monitoring in these systems indicates "healthy" populations that appear to be either increasing or stable. The population status in the rest of the Wenatchee River drainage, including Nason Creek, Little Wenatchee River, Chiwaukum River, and Icicle Creek, appears to be depressed. The status of the Deep and Ingalls Creek populations are unknown. Mad River (Entiat River tributary) bull trout appear stable.

There is some spawning in the Entiat River downstream of Entiat Falls, but numbers are very low; this subpopulation appears to be depressed (USDI, 1998; K. Macdonald, pers. comm., 2000). Within the Naches sub-basin, bull trout are found in the American River, Crow Creek, Rattlesnake Creek, and Bumping River. The bull trout population within Rattlesnake Creek, a tributary of the Naches River, appears to be stable with spawning occurring at relatively low numbers. Juveniles have been observed in the lower portion of several other tributaries of Little Naches River (K. Macdonald, pers. comm., 2000).

Within the Yakima sub-basin, bull trout are found in the North Fork Teanaway, Lake Kachess, Lake Cle Elum and Cle Elum River, and Lake Keechelus, including Gold Creek and Waptus River. Populations appear to be either stable or depressed (K. Macdonald, pers. comm., 2000).

The primary limiting factors to bull trout on the Wenatchee National Forest has been extensive fish harvest, habitat modification, and off-Forest development. Elevated stream temperatures may be a problem in some streams. Habitat alteration may have raised temperatures in some tributaries, but other stream temperatures are close to historic levels. This includes stream segments on the *303d* list (K. Macdonald, pers. comm., 1999). Host type stands include 45 linear miles of occupied bull trout habitat.

UMATILLA NATIONAL FOREST

Six watersheds provide habitat for Columbia River bull trout: Asotin, Grande Ronde, John Day, Tucannon, Umatilla, and Walla Walla Rivers (USDI, 1998). Bull trout in the headwaters of Asotin Creek are considered a depressed population (J. Sanchez, pers. comm., 1999 and Quigley et. al. 1997).

The Grande Ronde Watershed has bull trout in the main stem of the Grande Ronde River, Lookingglass Creek, and the Wenaha River. The Lookingglass population has declined; the *303d*-listed stream segment does not meet State water temperature standards. The Wenaha River and its associated tributaries have subpopulations of bull trout that are considered "strong". Part of this river is also listed on the *303d* list as not meeting State standards for water temperature (Quigley et. al. 1997; J. Sanchez, pers. comm., 1999).

Desolation Creek (John Day River watershed) has a "depressed" population. Like most John Day River tributaries, a segment Desolation Creek is listed on the *303d* state list for exceeding State water temperature standards (J. Sanchez, pers. comm., 1999).

The Tucannon River Watershed contains bull trout in Cummings Creek and the headwaters of Tucannon Creek. Both are considered "depressed" populations. (Quigley, et. al., 1997; J. Sanchez, pers. comm., 1999). Some Tucannon Creek headwaters are listed for stream temperature.

The Umatilla River Watershed contains Columbia River bull trout in the North Fork of Umatilla Creek and in Meacham Creek, with the North Fork providing most of the spawning and rearing habitat. Stream segments of both are listed on the *303d* list as being above State requirements for stream temperature.

The Walla Walla River Watershed contains bull trout in headwaters of two stems of the Walla Walla River and in Mill Creek. Although the Mill Creek subpopulation is showing improvement, the Walla Walla River headwater populations have declined (J. Sanchez, pers. comm., 1999). One segment of the Walla Walla River is *303d* listed for water temperature.

Limiting factors for Umatilla bull trout include small populations of mostly resident fish that are isolated by impassably warm water. Bull trout in the John Day Watershed also suffer from competition with brook trout. Stream temperature is more of a limiting factor in the southern part of the Forest where weather conditions are hotter and drier and where cattle grazing is common (J. Sanchez, pers. comm., 1999). There are approximately 180 linear miles of bull trout habitat in DFTM host type.

WALLOWA-WHITMAN NATIONAL FOREST

The Grande Ronde River, John Day River, and Salmon River watersheds provide habitat for Columbia River bull trout on the Wallowa-Whitman National Forest. In the Grande Ronde watershed, bull trout are found in the main stem of the Grande Ronde, lower reaches of the Wallowa River, Minam River, and Little Minam River. Of these, the Wallowa River population is classified as "depressed". Minam populations appear to be improving (Quigley, et. al., 1997).

In the John Day River watershed, only the North Fork John Day River and its tributaries provide bull trout habitat; the population is declining (Quigley, et. al., 1997).

Bull trout in the Salmon Watershed have been increasing in number, particularly in Big Sheep Creek and Rapid River and their tributaries. Other locations providing habitat for bull trout are the main stem of the Snake and Imnaha Rivers (plus tributaries). Their population status is unknown (Quigley, et. al., 1997).

Overall, many stream segments are *303d* listed for elevated stream temperature. There are approximately 180 linear miles of bull trout habitat in DFTM host type.

MALHEUR NATIONAL FOREST

The John Day Watershed provides habitat for bull trout in the following areas, the populations of which are all considered to be "depressed": Big Creek, Clear Creek (John Day River tributary), Indian Creek, upper reaches of John Day River, and Reynolds Creek (Quigley, et. al., 1997). The Malheur River watershed also contains "depressed" populations of bull trout: Little Crane Creek and some tributaries, upper reaches of the Malheur River, and Summit Creek and its tributaries (Quigley, et. al., 1997).

About half have segments on the *303d* state list for exceeding state stream temperature requirements. There are nearly 130 linear miles of bull trout habitat in DFTM host type.

OCHOCO NATIONAL FOREST

Although bull trout are believed to exist on the Ochoco Forest, no reaches have been verified as containing a subpopulation. The only documented reach (9 miles) with a known population of bull trout is west of the Forest, on the Crooked River National Grasslands, and outside the analysis area

Klamath River Distinct Population Segment: Historical records suggest that bull trout were once widely distributed and exhibited diverse life-history traits in the Klamath River Basin (USDI, 1998). Today, bull trout occur only as resident forms in isolated, high elevation headwater streams. They are found in only three watersheds: Upper Klamath Lake, Sprague River, and Sycan River (USDI, 1998). Contributing factors include habitat degradation, water diversion, and habitat fragmentation. In addition, long distances now separate each of the 7 subpopulations (C. Speas, pers. com., 1999).

WINEMA NATIONAL FOREST

One of the seven subpopulations of Klamath River bull trout occurs entirely on the Winema National Forest, in four miles of Threemile Creek. The population is considered to be at risk of extirpation, with less than 100 known individuals (D. Forbes, pers. comm., 1999). The main limiting factors to this subpopulation are its isolation and competition from brook trout (D. Forbes, pers. comm., 1999). Most of Threemile Creek is 303d listed for exceeding maximum stream temperature. However, previous temperature data might not be an accurate representation of the current situation. Recent temperature surveys show the upper section, which contains bull trout, is within acceptable levels (D. Forbes, pers. comm., 1999). DFTM host type borders only 2 linear miles of occupied bull trout habitat.

FREMONT NATIONAL FOREST

Five subpopulations of the Klamath River bull trout occur on the Forest and on surrounding private lands: Long Creek, Coyote Creek, North Fork Sprague River and its tributaries, Demming Creek, Brownsworth Creek, and Leonard Creek. All, except the Demming Creek population, are considered to be at risk from extirpation (USFS, 1998). The Demming Creek population is the strongest bull trout subpopulation in the Klamath Basin (C. Speas, pers. comm., 1999). Some portions of each of the bull trout occupied streams are 303d listed for stream temperature. Unfortunately, the data to determine 303d status was taken during a drought and may not be an accurate representation of current temperatures (C. Speas, pers. comm., 1999). Approximately 5 linear miles of occupied bull trout habitat is in DFTM host type.

Gray Wolf (Canis lupus)

Wolves are highly social animals, occurring in packs that establish and defend territories ranging from 48 square miles to over 981 square miles depending on pack size and prey density (Ballard, et al., 1997; Mech, 1987; Wise, et. al., 1991). This species inhabits a wide variety of habitats in which it requires an adequate food supply, suitable denning and rendezvous sites, travel corridors, and regulation of human caused mortality (USFWS 1987).

Two primary habitat components have been identified as important to wolf conservation: availability of prey and freedom from direct mortality (Fritts, 1994). Wolves prey primarily on ungulates, although birds and smaller

mammals are taken when available (Mech, 1970). Freedom from direct mortality is measured by changes in road densities. Wolves do not appear to avoid habitat associated with roads, but rather increases in road densities heightens the chances for direct mortality to wolves from poaching.

The Colville, Okanogan, and Wenatchee have had documented occurrences of the gray wolf. There have also been recent confirmed sightings of the gray wolf on all three Forests. The most likely habitat for this species is in areas of low road densities. This species has not been documented to occur on any of the other National Forests in the analysis area.

These three Forests, located in eastern and central Washington, contain habitat to support the entire home range necessary for the wolf. This includes den and rendezvous sites, abundant ungulate food base, as well as large tracts of land with low road densities.

There are no known rendezvous or den sites on the Colville National Forest. There are no known den sites or confirmed rendezvous sites on the Okanogan National Forest. There are no known den sites on the Wenatchee National Forest, although there are two known rendezvous sites. Ungulates are considered the main source of prey for wolves on the Colville National Forest. Deer and elk are common throughout the Forest, while caribou are present in small numbers within its northeast corner. Deer and occasionally small mammals and birds are suspected to be the main prey base for wolves on the Okanogan National Forest. Deer and elk are most likely the main prey base for wolves on the Wenatchee National Forest. Snow-intercept thermal and thermal cover are important habitat components for ungulates throughout the three Forests.

Calving and fawning areas for ungulates are mostly concentrated in the wide river bottoms and riparian areas where water, food, and shelter are in close proximity (cited in USDA 1991).

Woodland Caribou (Rangifer tarandus caribou)

Winter foraging is limited almost exclusively to lichens hanging from subalpine fir and Engelmann spruce trees. Throughout the rest of the year, caribou eat herbaceous vegetation, mushrooms, shrub leaves, grasses, sedges, and soft shrubs. In central British Columbia, caribou are known to forage in early winter at lower elevations under the tree canopy. The canopy cover intercepts snow and makes ground foraging easier. In summer, canopy cover offers protection from the heat and possibly insects (cited in USFWS, 1985).

Woodland caribou are known to commonly have large home ranges and low population densities (cited in USFWS, 1985). Although the Selkirk Mountain herd is thought to move freely between the United States and British Columbia, it is likely that the caribou use the United States habitats throughout the year. Observations of the species have been made in the U.S in every month of the year (cited in USFWS, 1985).

The Selkirk Mountain caribou are an ecotype of woodland caribou occupying the international border areas of northern Idaho, Washington, and southern British Columbia. The Selkirk population is the only woodland caribou herd frequenting the contiguous United States. They are also the only population listed as endangered. The Selkirk Mountain caribou inhabit the northeastern corner of the Colville National Forest, on the Sullivan Lake Ranger District. On the Colville National Forest, about 36,000 acres were delineated as caribou habitat. This area consists of the Salmo-Priest Wilderness, research natural areas, and lands available for timber harvest.

Grizzly Bear (Ursus arctos horribilis)

The grizzly bear is an omnivorous and secretive animal with movement patterns and variable habitat preferences highly influenced by their search for available seasonal foods. Seasonal foods include carrion, preying on ungulates, small mammals, fish, insects, herbaceous plants, roots, bulbs, tubers, fungi, tree cambium, berries, and nuts (Martinka, 1972; Pearson, 1975; Hamer, et. al., 1977; Singer, 1978). The pattern of grizzly bear movements in the Northern Rockies is to emerge from high elevation snow covered den sites in April, descend to lower elevations to reach palatable emerging vegetation and feed on carrion or weakened ungulates. From late spring through early summer grizzly bear follow the "greening up" of vegetation, seeking similar forage components as early spring. During late summer and fall grizzly bear feed on ripening berries to build up critical carbohydrate reserves needed to maintain body weight during winter denning (Sevheen and Lee, 1979).

Craighead, et al. (1982) described seven characteristics essential to grizzly bear habitat: space, isolation, sanitation, denning, safety, vegetation types, and food. When any one of these components is missing, the viability of grizzly habitat rapidly diminishes (Almack, 1986).

Almack, et. al., (1993) identified 22 Class I (confirmed) and 82 Class II (high reliability) observations in the North Cascades of Washington and the Southern Cascades of British Columbia, Canada. The Wenatchee, Okanogan, and Colville National Forests have documented occurrences of grizzly bears within their boundaries. The northern and central portions of the Wenatchee National Forest occur within the North Cascades Grizzly Bear Recovery Zone and include the Chelan, Cle Elum, Entiat, Lake Wenatchee, and Leavenworth Ranger Districts. The portion of the Okanogan National Forest, specifically the Methow Valley Ranger District and the far western portion of the Tonasket Ranger District, occurring west of the Okanogan River is also located within the Recovery Zone. The grizzly bear recovery zone within the Colville National Forest occurs within and east of the Pend Oreille Valley, within the Sullivan Lake Ranger Districts.

Canada Lynx (Lynx canadensis)

Lynx occur primarily in the boreal, sub-boreal, and western montane forests of North America (Koehler and Aubry, 1994). Primary lynx habitats in Washington and

Oregon are dominated by Engelmann spruce, subalpine fir, and lodgepole pine (Koehler 1990).

Snowshoe hares are the primary prey of lynx, comprising 35-97% of the diet throughout the range of the lynx (Koehler and Aubry, 1994). There is little research on lynx diet specific to the southern portion of its range except in Washington (Koehler, et. al. 1979, Koehler, 1990). In areas characterized by patchy distribution of habitat, alternate prey could include white-tailed jackrabbit, black-tailed jackrabbit, ground squirrels, sage grouse, and Columbian sharp-tailed grouse (cited in USDI 1999). Early successional forests and structurally diverse older stands supporting forage for snowshoe hares provide foraging habitat for lynx. In Washington, hares were more abundant in younger aged stands of lodgepole pine than in any other forest type (USDA 1994b).

The common component of lynx denning habitat is large woody debris, either downed logs or root wads (cited in USDI 1999). Stand structure appears to be of more importance than forest cover type. Large amounts of large coarse woody debris provide escape and thermal cover for kittens (cited in USDI 1999).

The following Forests within the project area have documented occurrences of lynx: Colville, Okanogan, Wenatchee, Wallowa-Whitman, Umatilla, and Fremont. The Winema and Ochoco Forests have suspected occurrences of lynx.

Historical and current lynx distribution is primarily east of the Cascade Mountains in Washington, mainly on the Okanogan National Forest (Washington Department of Fish and Wildlife 1993). Lynx distribution on the east side of the Washington Cascades appears to be closely related to the distribution of the subalpine fir/Engelmann spruce plant associations which have lodgepole pine as a seral species (Koehler and Brittel, 1990).

Current records indicate a similar distribution, but with fewer reports from some areas, such as the Colville National Forest, located in northeastern Washington. Lynx have been documented at elevations ranging from 3,000 feet to near the upper tree line. The lower limit, near 3,000 feet, is closely correlated with cool/moist habitat types. Lynx appear to make use of the lower elevation western redcedar and hemlock forest within the landscape, a trait perhaps unique to this region (cited in USDI 1999). Portions of the Wallowa-Whitman, Umatilla, Ochoco, and Malheur National Forests may provide connective / dispersal habitat to support movement between the northern Rocky Mountains and the Oregon Cascades. Information of lynx occurrence in central Oregon is limited (cited in USDI 1999).

Northern Bald Eagle (Haliaeetus leucocephalus)

The entire project area is incorporated within the Pacific Bald Eagle Recovery Plan (USFWS, 1986). Bald eagle nests within this Recovery Plan area are usually located in multi-storied stands with old-growth components, and are near water bodies that support an adequate food supply

(USFWS 1986). Adequate forage sources are possibly the most critical component of bald eagle breeding and wintering habitat. Fish, waterfowl, rabbits, and various types of carrion comprise the most common food sources for eagles in the Pacific Recovery Plan area. Wintering bald eagles perch on a variety of substrates, proximity to a food source being the most important factor influencing perch selection. Eagles tend to use the highest perch sites available that provides a good view of the surrounding area (USFWS 1986). Communal roost areas are invariably near a rich food source and in forest stands that are multi-storied and have at least a remnant old growth component (USFWS, 1986).

Habitat loss is the most significant threat to bald eagle populations in the 7-state recovery area. It is recommended in the Pacific Bald Eagle Recovery Plan that forested habitat being presently used by eagles be maintained (USFWS, 1986). The increasing disappearance of old growth and late/old structure stands makes it imperative that existing habitat be protected where appropriate. The Recovery Plan also states that in some cases special actions should be taken to maintain existing habitat for the bald eagle (USFWS, 1986).

The bald eagle is listed by the U.S. Department of Interior as a threatened species in Washington and Oregon. The primary threat to bald eagles in Washington and Oregon has been habitat degradation (WDW 1989). The entire analysis area falls within the 7-state Pacific Recovery Area for the bald eagle. Seven of the nine National Forests within the analysis area have recently had active bald eagle nests occur on NFS lands and are as follows: Colville, Wenatchee, Umatilla, Wallowa-Whitman, Ochoco, Winema, and Fremont. There are no recent, active bald eagle nests on the Malheur and Okanogan. There is potential habitat and known bald eagle nest sites nearby. Typically, 0.25 miles (125 acres) surrounding bald eagle nests is considered core habitat for the species in the Pacific Northwest (G. Gunderson, per. com. 1999).

Northern Spotted Owl (Strix occidentalis caurina)

Studies of habitat use suggest, with few exceptions, that stands with old-growth forest structural components are superior habitat for the northern spotted owl (USDA 1992). Spotted owls consistently concentrate their foraging and roosting in old-growth or mixed-age stands of mature and old-growth trees (USDA 1992). For nest sites, spotted owls primarily use old-growth trees, whether in old-growth stands or in remnant old-growth patches (USDA, 1992). The diet of spotted owls consists primarily of small mammals. Wood rats and flying squirrels compose the majority of the prey biomass eaten by these owls (USDI, 1992).

The northern spotted owl is a medium-sized owl found primarily in western Washington and Oregon of the Pacific Northwest, and is listed as a threatened species under the Endangered Species Act. The analysis area includes the eastern most edge of the range of the spotted owl and includes the Wenatchee National Forest, and the western parts of the Okanogan and Winema National Forests. The

eastern portion of the Okanogan and Winema National Forests are considered to be outside the range of the species.

Spotted owl populations on the Okanogan and Wenatchee National Forests occur in the **Eastern Washington Cascades province**, located east of the Cascade Crest from the Columbia River north to the Canadian Boarder. Most spotted owl habitat in this area is found in the Yakima Indian Reservation and four Ranger Districts on the Wenatchee National Forest: Naches, Cle Elum, Leavenworth, and Lake Wenatchee. Much of the region is dominated by high-elevation mountains and ridge-tops that are not suitable spotted owl habitat. These topographic features restrict the suitable spotted owl habitat to low-elevation, mixed conifer forests. Much of these lower elevation habitats have been logged extensively, but primarily with partial-harvest techniques. Spotted owls and their habitat are poorly distributed in the portion of the Okanogan National Forest within the range of the species, and the Chelan and Entiat Ranger Districts of the Wenatchee National Forest (USDI, 1992).

The eastern Washington Cascades province is isolated somewhat from other spotted owl subpopulations on its northern, southern, and western boundaries. The two spotted owl provinces that comprise the Washington Cascades are connected by contiguous habitat and owls in only a few areas. The northern portion of the province is virtually at the edge of the species' current range, and the few spotted owls within this region are isolated from the larger groups of owls south of Lake Chelan. The degree of province isolation in the Columbia River area is unknown (USDI, 1992).

Spotted owl nest stands within the Okanogan and Wenatchee National Forests are dominated by Douglas-fir and grand fir, with some ponderosa pine, western larch, western red cedar, and western hemlock. The nest stands are found either in old growth habitat, or young/mature stands containing remnant old-growth trees (USDI, 1992). In one study in the eastern Washington Cascades, total canopy cover averaged 75 percent in 62 nest sites and 72 percent in the stands within which the nests were found (USDI, 1992). In the same province, total canopy cover in roosting and foraging sites averaged 47 percent in six home ranges (USDI, 1992).

The spotted owl population on the Winema National Forest occurs within the **Eastern Oregon Cascades province**. This province consists of a narrow band of habitat extending north-to-south along the east side of the Cascade crest from the Columbia River to the California border. Habitat suitability for the owls within the Winema National Forest is found in the mixed conifer zone existing between the high-elevation subalpine and mountain hemlock forests and the lower elevation lodgepole / ponderosa pine areas. Habitat and owls are poorly distributed through many areas of the province, including the Winema National Forest. Natural conditions (e.g. soils and moisture conditions), past fire history, and timber harvest have contributed to the isolated nature of the

habitat. In addition, the high-elevation subalpine and non-forested conditions along 40 percent of the Cascade crest makes the eastern Oregon Cascades province relatively isolated from the western Cascade province (USDI 1992).

There is a significant potential for large-scale fire in the eastern Washington (Okanogan and Wenatchee National Forests) and Oregon (Winema National Forests) Cascade province. A total fire suppression strategy has created the multi-layered yet unstable forest structure present on this landscape today. There is a very low probability that any conservation area in the East Cascades subregion will avoid catastrophic wildfire over a significant portion of the landscape over the next century. As spotted owls in the province currently are clustered in a few key areas, fire poses a severe natural threat to population recovery (USDI 1992).

Fire exclusion, coupled with natural mortality factors, gradually reduces the pine and larch components of mixed conifer stands. Thus, the resulting multistoried stands of Douglas-fir and true fir create conditions for the buildup of defoliators, such as the western spruce budworm and Douglas-fir tussock moth. Populations are predicted to increase, with more frequent outbreaks (USDI 1992).

SENSITIVE SPECIES

Forest Service Manual 2670.5 directs the Regional Forester to identify species for which there is a viability concern as evidenced by a) significant current or predicted downward trends in population numbers or density or b) significant current or predicted downward trends in habitat capability that would reduce a species' existing distribution. Once "sensitive species" have been identified, the Forest Service must assess the effects of actions or projects on such species and ensure that those actions or projects do not cause a loss of species viability or create significant trends toward Federal listing (*FSM* 2670.32). Habitat for these species is widely varied, ranging from aquatic environments to upland forests, shrub lands, and grasslands. Table III-10, below, displays the 35 documented (D) or suspected (S) occurrence of sensitive species on National Forests within the analysis area.



Table III-10: Regional Forester's List of Sensitive Animal Species in the Project Area

	COL	OKA	WEN	UMA	W-W	MAL	OCH	WIN	FRE
AMPHIBIANS									
Larch Mountain Salamander			D						
Oregon Spotted Frog								S	S
Columbia Spotted Frog		D		D	D	D	D		
Northern red-legged frog			D						
BIRDS									
Common loon	S	D	D			D	D	D	
American white pelican		D	D					D	D
Ferruginous hawk			D						
American Peregrine Falcon	S	S	D	S	S	S	S		D
Western sage grouse						D	D		D
Greater sandhill crane		S	D		D	D	D	D	D
Long-billed curlew		D	S		D	D	D	D	D
Upland sandpiper			S		D	D	S		
Tricolored blackbird					D	S	S	S	S
Harlequin duck	D	D	D		D				
Yellow rail								D	S
Black rosy finch				S	D				
FISH									
Interior redband trout	D	D	D	D	D	D	D	D	D
Oregon Lakes tui chub									S
Goose Lake Sucker									D
Klamath largescale sucker								D	D
Malheur mottled sculpin						D	D		
Pit sculpin									D
Slender sculpin								D	S
Mid Columbia fall chinook salmon							I		
Mid Columbia spring chinook salmon			D	D		D	I		
INVERTEBRATES									
Schuh's homoplectran caddisfly								S	
Cascades apatanian caddisfly								S	
Blue Mountain cryptochian caddisfly				S	D	D	D		
Ft. Dick limnephilus caddisfly								S	
MAMMALS									
Preble's shrew					D	D	D		
Pacific western big-eared bat		D	D					S	
Pygmy rabbit						S	S		D
California wolverine	D	D	D	S	D	D	D	D	S
California bighorn sheep	D	D	D	D	D	D	D		D
REPTILES									
Northwestern pond turtle			S					D	D

MANAGEMENT INDICATOR SPECIES & OTHER WILDLIFE

Management Indicator Species (MIS) are a group of wildlife species that represent other wildlife species with similar habitat requirements, and which are the focus of management and monitoring on the National Forests. Forest management is prescribed to ensure viability of these selected species as well as other species that they

represent. Protection of these species is based upon the habitat requirements of the MIS.

Table III-11, below, is a list of the Management Indicator Species considered in this analysis

Table III-11: Management Indicator Species

	COL	OKA	WEN	W-W	UMA	MAL	OCH	WIN	FRE
BIRDS									
Bald Eagle			X	X		X	X	X	X
Golden Eagle							X		
Peregrine Falcon			X	X		X			X
Prairie Falcon							X		
Goshawk				X				X	X
Spotted Owl		X	X					X	
Barred Owl	X	X							
All Primary Cavity Excavators	X	X	X	X	X	X	X	X	X
Pileated Woodpecker	X	X	X	X	X	X	X	X	X
Three-toed Woodpecker	X	X	X	X	X	X		X	X
Red-Naped Sapsucker									X
White-headed Woodpecker				X		X			
Northern Flicker							X		
Great Blue Heron	X								
Blue Grouse	X								
Ruffed Grouse		X	X						
Franklin's Grouse	X								
FISH									
Steelhead		X			X	X	X		
Chinook salmon		X	X			X			
Westslope Cutthroat trout			X						
Resident trout	X	X			X		X	X	X
Anadromous fish				X					
MAMMALS									
Elk			X	X	X	X	X		
Deer	X	X	X			X	X	X	X
Mountain Goat			X						
Mountain Caribou	X								
Grizzly Bear	X								
Lynx		X							
Pine Marten	X	X	X	X	X	X		X	X
Beaver	X		X						
Northern Bog Lemming	X								

LEPIDOPTERA

Studies have identified from 458 to 498 species of moths and butterflies in a typical coniferous forest (Grimble, 1995; Miller, 1995). Most of these species (approximately 80%) are adapted for growth in early spring to coincide with new foliage for feeding. Different geographic areas throughout the Forest of eastern Washington and Oregon have roughly the same number of species; of those species, perhaps 20% may differ between geographical regions (Hammond, pers. comm.). Most species belong to the Noctuidae and Geometridae families (Grimble, 1995; Miller, 1995). In eastside western coniferous forests, approximately 12% of the moth species, and 5% of the moth abundance are found in the conifer habitat. Most of the species occur in hardwood habitat (52%) and herb/grass habitat (33%) (Hammond and Miller, 1998). There are no federally threatened or endangered Lepidoptera within the project area. There are no Lepidoptera on the Regional Forester's Sensitive species list. The Mardon skipper (*Polites mardon*) is a candidate for Federal listing. This insect is also a Washington Department of Fish and Wildlife State listed species. It does not occur within the analysis areas of this EIS in Washington. There are also 11 species of butterflies on the Washington State candidate list. Four are known to occur within the analysis area: Juniper Hairstreak (*Callophrys [Mitoura] gryneus*), Silver-bordered Fritillary (*Boloria selene*), Great Arctic (*Oeneis nevadensis*), and Shepard's Parnassian (*Parnassius clodius shepardi*). Two other species, the Johnson's Hairstreak (*Callophrys johnsoni*) and the Yuma skipper (*Ochlodes yuma*) have not been found in the project area (information based on *Butterflies of North America*; *Butterflies of Washington*).

Oregon does not have any State listed Lepidoptera. There have been confirmed sightings of the Mardon skipper in Klamath County. There are some analysis areas on the Winema NF that occur within this County, however, it is not known whether Mardon skipper colonies occur in the vicinity of these areas. Two species listed as rare or local throughout its range by the Nature Conservancy are the Sierra Nevada Blue (*Agriades podarce*) and the Johnson's Hairstreak. The Sierra Nevada Blue has been recorded in Klamath County, which contains analysis areas on the Winema NF. The Johnson's Hairstreak has not been recorded in any counties containing analysis areas. Eleven other species that may be considered rare in parts of their range or because they occur on the periphery of their range, or as a subspecies, include Rural Skipper (*Ochlodes agricola*), Gold-hunter's Hairstreak (*Satyrrium auretteorum*), Long Dash (*Polites mystic*), Eastern Meadow Fritillary (*Boloria bellona toddi*), Barnes' Crescent (*Phyciodes pallidus barnesi*), Peck's Skipper (*Polites peckius* (=coras)), Beartooth Copper, (*Lycaena phalaes arctodon*), Hoary Elfin (*Incisalia polia obscura*), Garita Skipperling (*Oarisma garita*), Yuma Skipper (*Ochlodes yuma*), and Silver-bordered Frillary (*Boloria selene tollandensis*). This information is based on *Butterflies of North America*; *Butterflies of Oregon*, and Scott, 1999.

DOUGLAS-FIR TUSSOCK MOTH

BACKGROUND AND LIFE CYCLE

The Douglas-fir tussock moth is a native defoliator that occurs throughout the west from southern British Columbia to Arizona and New Mexico, and east to Colorado. It was first recorded in 1900, and the first outbreak was recorded in British Columbia in 1916. Although the insect occurs throughout the west, outbreaks most frequently occur east of the Cascades and west of the Rockies. It can be found west of the Cascades, but never reaches outbreak proportions. The first details of a large infestation in the U.S. are from an extensive outbreak that occurred in the Northwest in 1927-1930. Since then, a variety of major and minor outbreaks continued to be recorded throughout the interior forests of the western U.S. (Mason and Wickman, 1988). The most recent widespread outbreak in the Pacific Northwest (Oregon, Washington, and Idaho) occurred in 1972-1974 when almost 700,000 acres were defoliated. A more recent smaller outbreak occurred in northeastern Oregon on the Pine Ranger District; 116,000 acres were treated in 1991. At that time, a large outbreak covering 418,000 acres occurred in southern Idaho (Weatherby, et. al., 1997). The most recent outbreak occurred in California, 1996-1999.

Douglas-fir tussock moths reproduce one time per year. The eggs are laid in the fall on the underside of branches with usually 150-250 eggs per mass. The insect overwinters in the egg stage. Eggs hatch in the early spring at the same time that buds break and new shoots begin to expand. These events are closely synchronized. The young larvae feed on the new shoots, and then switch to older needles as they mature. Trees that are being defoliated have a red appearance. The larvae feed for about 60 days, spin cocoons, pupate for about 2 weeks, and emerge as adults. The females are wingless and remain on the cocoon. The male finds the female by a sex attractant or pheromone. After she mates, the female deposits her eggs on the cocoon.

The cyclic nature of Douglas-fir tussock moth populations is well documented (occurring every 7-10 years), although these cyclic peaks do not always reach outbreak levels (Mason, 1996). A number of theories have been proposed to explain this cyclic nature, but the actual reasons are not known. Population peaks do not always go to outbreak. What happens to the larval generations in the early phase of the population cycle will determine whether the populations will cross to outbreak levels or return to low levels. Once a population reaches outbreak levels, the outbreak rarely persists in the same stand for more than 2-3 years. (Mason and Wickman, 1988). Outbreak densities

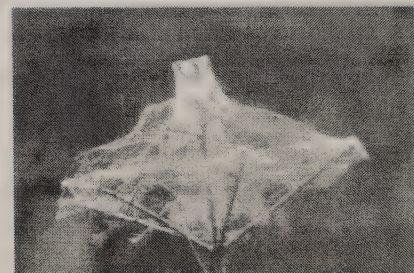


Figure III-3: Larval Web

have been measured as high as 300 – 600 caterpillars per 1000 sq. inches of foliage (equivalent to about 3- 18 inch branch tips). The primary host species are Douglas-fir, true fir and white fir. During outbreaks, the larvae have been known to defoliate ponderosa pines that are intermixed with the host species, snowberry, and even grass (Gregg, pers. comm.). Outbreaks collapse as quickly as they begin because of high densities, starvation, and disease.

ROLE OF DOUGLAS-FIR TUSSOCK MOTH IN THE ENVIRONMENT

The Douglas-fir tussock moth is a native insect, and it acts as a natural disturbance agent when outbreaks occur. In many areas, the pattern of gradual stand dominance by Douglas-fir and/or true fir is a result of natural succession, lack of ground fires, or previous management practices. Outbreaks serve as one way to return parts of these areas to stand initiation (or early successional stages). Heavy defoliation and tree mortality (either directly from the defoliation or from secondary mortality from bark beetles) creates openings of various sizes – some are small, consisting of only a few acres, to others that can be quite large – 500 to 1,000 acres. These openings can result in increased patches of shrubs, grasses, and cover plants, (Youngblood and Wickman, in press); and allows the return of seral tree species such as ponderosa pine and larch (Wickman, et. al., 1986). Large, dead trees provide snags and wildlife habitat (Youngblood and Wickman, in press). The dead needles and frass from the feeding insects return high amounts of nutrients to the soil for the short term, and larger woody material provides a longer-term nutritional base.

STATUS OF THE CURRENT DOUGLAS-FIR TUSSOCK MOTH POPULATION

Scientists have developed sampling techniques to monitor DFTM populations as they fluctuate and to determine which of these fluctuations will lead to an outbreak. The Early Warning Trapping System uses a sex attractant to lure male moths into the trap. This method consists of a series of traps placed each fall in permanent sites throughout eastern Washington and Oregon. Douglas-fir tussock moth populations and fluctuations have been monitored for over 20 years with this trapping system. If the average number of male moths in a trap goes over 40, a second level of ground sampling (sampling larval and pupal/egg mass life stages) is initiated (see Appendix D for a more detailed description of sampling procedures and sequence). This increasing number of trap catches between 1997 and 1998 led the Forest Service to conclude that a Douglas-fir tussock moth outbreak was imminent. This has been confirmed in some areas by the larval and pupal/egg mass surveys, and the 1999 aerial detection survey picked up about 21,000 acres of Douglas-fir tussock moth defoliation on the Pine Ranger District of the Wallowa-Whitman National Forest. Additional light defoliation has been reported from ground observations on other portions of the Wallowa-Whitman and Umatilla National Forests. Although the increase in DFTM

populations is well documented, the extent and exact locations of the outbreak cannot be predicted. The distribution of high trap counts throughout eastern Oregon and Washington indicates this outbreak will be more widespread than 1991 outbreak.

PLANTS

COLVILLE NATIONAL FOREST

There are no known threatened, endangered, or proposed plants on the Forest. It is not in the Survey and Manage zone. There are 35 sensitive species documented or suspected to occur on the Forest. Several *Botrychiums* have been found but most are in cedar types or wetlands. *Cypripedium parviflorum* occurs in Douglas-fir host types.

OKANOGAN NATIONAL FOREST

There are no known threatened, endangered, or proposed plants on the Forest. There are no known sensitive plants in host type. Most of the Forest sensitive species are wind pollinated or pollinated by non-Lepidoptera insects. The mountain dandelion, *Agoseris elata*, is known to have a Lepidoptera pollinator but resides in meadows outside host type. There are several Survey and Manage species. Candy stick (*Allotropa virgata*) is a shade dependent species that lives (probably as a saprophyte) in the understory of Douglas-fir and true fir types. Most *Botrychiums* on this Forest occur in non-host type. The fungus *Bridgeporus nobilissimus* occurs in the noble fir zone but out of proposed protection areas. Survey and Manage lichens and most bryophytes are not in proposed protection zones. None of these species has Lepidopteran spore transmittal agents. It is doubtful that there are any Lepidopteran pollinators of *Allotropa virgata*.

WENATCHEE NATIONAL FOREST

Ute ladies tresses (*Spiranthes diluvialis*), a federally threatened species are suspected to occur on the Wenatchee. The plant is known to occur on private land north of Okanogan but has not yet been found on the Wenatchee Forest. No information on local pollinators is available. Bumblebees are apparently required for successful pollination in Idaho and Montana (Ruesink, 1997). It is unlikely that this species requires a Lepidopteran for pollination. Wenatchee Mountain Checkermallow (*Sidalcea oregana calva*) is listed as federally endangered. It lives in wet meadows but could occupy forested habitats. Lepidopterans are known pollinators for this species. Showy Stickseed (*Hackelia venusta*) is proposed for listing as an endangered plant. IT is found in stressed Douglas-fir habitats on sandy soils at low elevations. The only known population of about 150 individuals occurs in the Tumwater Canyon Botanical Area. Low seed production and lack of genetic variation constitute an internal threat. Trampling by visitors, unstable slopes, fire suppression, and competition from noxious weeds have also been identified as threats. Pollinator biology is not well documented. Lepidopterans are not known to be essential pollinators of this plant.

Approximately 50 sensitive species are documented or suspected to occur on the Wenatchee National Forest. Half are believed to occur in DFTM host type. There are no Survey and Manage species on the Forest.

UMATILLA NATIONAL FOREST

There are no threatened, endangered, or proposed plants on the Umatilla Forest. Habitat for Ute ladies tresses is known to exist on the Washington side of the Forest but existence of the plant has not been documented. The Umatilla is not in the Survey and Manage zone. There are 35 sensitive plant species documented or suspected on the Forest. Species occurring in the Douglas-fir and true fir host types include *Cypripedium fasciculatum*, several *Botrychiums*, *Bolandra oregana*, and *Ranunculus populago*. *Cypripedium fasciculatum* is found in the understory of firs with at least 60% shade. *Bolandra oregana* is found on cliff faces in grand fir types. *Ranunculus populago* is a riparian species in host type.

WALLOWA-WHITMAN NATIONAL FOREST

A federally threatened species, McFarlane's four o'clock (*Mirabilis macfarlanei*) occurs on the Forest but is located in the grasslands of Hell's Canyon (non-host type). A recently proposed species, Spaulding's catchfly (*Silene spauldingii*) is a Palouse prairie resident that does occur on edges of Douglas fir types. *Howelia aquatilis* also occurs on the Forest but is not likely to occur in host type. The Wallowa-Whitman is not in the Survey and Manage zone.

There are 68 sensitive plants documented or suspected on the Wallowa-Whitman. Twelve *Botrychiums* and 20 other sensitive plants occur in DFTM host type. Information is lacking on Lepidopteran pollinators. However, one sensitive species of *Leptodactylon* has a known Lepidopteran pollinator. This species does not occur in potential protection areas. *Phlox multiflora* may also have a Lepidopteran pollinator.

MALHEUR NATIONAL FOREST

There are no threatened, endangered, or proposed plants on the Malheur Forest. The Forest is not in the Survey and Manage zone. There are 23 species of sensitive plants documented or suspected on the Malheur. Species occurring in or near host type include: *Thelypodium ucosomum* (in open sites), *Luina serpentina* (on steep rock outcrops adjacent to Douglas-fir forests), and *Phacelia minutissima* (in grand fir types). Lepidoptera pollinators are not currently known to be essential for any of these plant species.

OCHOCO NATIONAL FOREST

There are no threatened, endangered, or proposed plants on the Ochoco. Habitat suitable for Ute ladies tresses exists but no plants have been found. The Ochoco is not in the Survey and Manage Zone. There are 25 sensitive plant species. *Botrychiums* may occur in host type but that is not their primary habitat on the Ochoco. *Calochortus longebarbatus* var. *peckii*, live in meadows in the Douglas-fir zone and the Douglas-fir/grand fir types. However,

because it is a sterile triploid, it is not pollinated. All of the sensitive species on the Ochoco are shade tolerant. *Cypripedium calceolus* is reported as occurring on the Forest but the taxonomy is not certain and it may be a color morph of the yellow orchid *C. montanum*.

WINEMA NATIONAL FOREST

There are no known threatened, endangered, or proposed plants on the Winema National Forest. *Spiranthes diluvialis* and *Howelia aquatilis* are found just outside Forest boundaries. One Survey and Manage species, *Cypripedium montanum*, occurs on Chiloquin Ridge primarily in coniferous understories with 50-60% shade. It is bee pollinated with no known Lepidopteran pollinators. There are also 10 sensitive plants documented or suspected to occur on the forest. Of these, only *Collomia mazama* and blue-leaved penstemon reside in DFTM host type.

FREMONT NATIONAL FOREST

There are 14 sensitive plant species on the Forest. Two occur in host type.

HUMAN ENVIRONMENT

HUMAN HEALTH



The health and safety of people are influenced by many factors including diet, climate, diseases, contaminants in the soil and water, emotional well-being, and access to medical facilities. This analysis concerns itself with the potential or perceived health effects associated with the Douglas-fir tussock moth and proposed actions. Human health effects include those effects related to the exposure and potential effects of treatment with insecticides, and the effects related to exposure to the Douglas-fir tussock moth.

Throughout the analysis area, there are many sites used by humans - recreation sites, resorts, camps, worksites, and small communities. People who live in or near areas where there are host type trees could be affected by the Douglas-fir tussock moth and people who live near proposed treatment areas could be exposed to the biological control agents. These people may include individuals with allergic reactions, respiratory ailments, or chemical sensitivities; immuno-compromised individuals, children, and the elderly. Individuals who work in the forest environment or with trees, who mix or apply the pesticides, or recreate within the forest could be exposed to the moth or the proposed treatments.

RECREATION SITES

Recreation sites tend to have high levels of investment in infrastructure and services, leading to high losses in recreation value from the physical damage and nuisance effects of an insect outbreak. In particular, campgrounds, summer homes, camps, visitor centers, scenic vistas, and other places of concentrated recreation use are affected. Larvae and fecal pellets fall on picnic tables, cars, and tents. Sites that are especially unique, popular, or can accommodate more visitors suffer because comparable substitute sites are not available. The following is a summary of the high-use and high-risk recreation sites per Forest. A complete list for each Forest appears in Appendix J.

Colville = 12	Okanogan = 69
Wenatchee = 27	Umatilla = 31
W-W = 7	Malheur = 16
Ochoco = 16	Winema = 1
Fremont = 0	

RESIDENTIAL & ADMINISTRATIVE SITES

Residential and administrative sites include offices, work centers, residences, camps, resorts, and other places where people work and live within the boundaries of National Forest lands. These sites are prone to the same health and nuisance problems that afflict high use recreation sites. However, residential and administrative sites are generally permanent facilities that cannot be reasonably avoided in favor of alternate locations during a tussock moth outbreak. If unable to temporarily relocate or suspend occupancy, people can suffer from exposure to the insect or absorb a substantial loss or inconvenience by staying away. The following are the high-risk residential and administrative sites per Forest. A complete list for each Forest appears in Appendix J.

Colville = 0	Okanogan = 7
Wenatchee = 7	Umatilla = 15
W-W = 0	Malheur = 1
Ochoco = 4	Winema = 2
Fremont = 0	

MUNICIPAL WATERSHEDS

Four of the nine National Forests contain municipal watersheds that could be affected by a Douglas-fir tussock moth outbreak:

- ☛ **Umatilla:** Walla Walla watershed (Mill Creek)
- ☛ **Wallowa-Whitman:** Baker City and Sumpter City watersheds
- ☛ **Malheur:** Canyon City watershed (Byram Gulch)

Refer to the previous discussion on Water Quality, page III-13, for more information on water quality. One outcome from defoliation is buildup of fuels and increased risks from fire. Also, refer to the discussion on Fire, page III-9.

- The issue of elevated fire risk in five municipal watersheds was raised during scoping and in comments to the draft Environmental Impact Statement. Table I-12 displays the areas within each municipal watershed that are categorized by the 20-60% and the 60-100% host types, as well as the total area of the watershed.

Currently, risk of fire is relatively high to very high for each of these watersheds and access in these watersheds is generally limited. There is a significant amount of host type within each watershed (from 47 to 61 percent of the National Forest land area within each watershed), increasing the probability of effect from an outbreak.

Table III-12: Host Type in Municipal Watersheds

WATERSHED	20- 60% HOST TYPE ¹² (% NF AREA ¹³)	60-100% HOST TYPE (% NF AREA)	WATERSHED AREA ON NATIONAL FOREST LANDS
Baker City and City of Sumpter Municipal Watersheds Wallowa-Whitman NF	3,984 (24%)	4,757 (29%)	16,424
Canyon City Municipal Watershed Malheur NF	45 (16%)	106 (38%)	279
City of Walla Walla Municipal Watershed Umatilla NF	1,817 (9%)	10,461 (52%)	20,268

¹², 20-50% host type for the Malheur NF only

¹³ Percent of National Forest lands in the watershed with host type

SCENIC AREAS

Scenery is the general appearance of a place described in terms of line, color, texture, and form. Both "natural" appearing and cultural landscapes may be highly valued by the public. Scenery is a product of both natural processes and human-induced change, the latter having a major influence even on the naturally appearing landscapes characteristic of National Forest system lands. National Forests serve as visual backdrops for communities, residences, and recreation areas throughout eastern Oregon and Washington. People generally accept that landscape settings are dynamic and that visual settings change over time, though most people do not prefer drastic changes. Changes in scenic value are more apparent in foreground views than in middle ground or background views.

Foreground Views

Foreground view areas are designated in Forest Plans because of their high exposure to humans through either travel corridors or other areas of relatively high amount of recreational use. Five National Forests in eastern Oregon and Washington identified scenic foreground Areas of Concern that fell in host type for the Douglas-fir tussock moth, and that warranted protection from the tussock moth.

The National Forests in eastern Oregon and Washington identified foreground areas that fell in host type for the Douglas-fir tussock moth and that could be degraded by defoliation. The visual impact from tussock moth damage is usually greatest in campgrounds and other recreation sites where the loss of even a few trees can make a noticeable difference. However, views along popular travel corridors or from communities near National Forest boundaries can also be significantly affected.

The highest visual impact from tussock moth damage would likely be in stands composed of from 60 to 100 % host type species. In these stands, heavy damage to trees usually occurs in patches of from several acres to several hundred acres in size. In the outbreak of 1972 / 1973, about 12% of the area consisted of areas of either 100% mortality or over half the trees totally defoliated. In the latter case, 75% tree mortality resulted. About 40% of the area resulted in half the trees being over one quarter defoliated from the top down. In this case, about 10% tree mortality occurred (USDA Forest Service, 1974). Uniform and contiguous defoliation would most likely occur in areas consisting of predominant host type species and with multiple canopy layers. Visual impact will be most evident when trees have the obvious red appearance of defoliation during the years that the outbreak is occurring. Research on one outbreak found that half the severely defoliated trees that survived appeared normal within two years and 98% appeared normal within ten years.

The following table shows the extent of risk for defoliation in the scenic Areas of Concern identified by the forests. High risk and to some extent, medium risk, would likely be areas of greatest potential impact to visual quality. Low risk would not likely result in noticeable degradation.

High-risk areas are generally composed of mostly 60-100% host type. Medium-risk area also contain large portions of 60-100% host type which could, if defoliated, result in a noticeable visual impact to many.

Table III-13: Acres in Foreground Scenic Areas

FOREST	LOW RISK	MEDIUM RISK	HIGH RISK
Okanogan	43,450	42,990	4,680
Wenatchee	970	2,930	940
Umatilla	11,600	41,720	13,920
Malheur	12,090	20,010	1,530
Ochoco	3,930	3,060	650
Total	72,040	110,710	21,720

Background Views

Distant view areas, consisting of middle and 'backdrop' views, were not among those areas initially identified for protection in the Purpose and Need. The inclusion of these areas in the analysis stemmed from public comment that sought better protection of current forest conditions. Forest Plans designated categories of "middle-ground" and background scenic areas. Generally, these landscapes are large and absorb modest changes without harm to scenic values. As travelers get closer to these views, the features become more apparent and changes in vegetation are more noticeable. Backdrop views should not be diminished by tree defoliation and mortality from tussock moth. Still, tussock moth damage would be evident to local viewers, especially in the short term. Since specific distant view areas were not identified for this plan, effects are estimated to be proportional to the number of acres of host type in three risk classes on each National Forest. The more acres and the higher the risk, the more likely backdrop scenic areas would be negatively affected by tussock moth.

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SUMMARY OF CHANGES BETWEEN DRAFT AND FINAL

Reorganized discussion of effects.

Clarified and expanded the discussion of effects regarding project issues.

Added or clarified specific discussions on threatened, endangered, proposed, sensitive, Survey and Manage, and other wildlife and plants.

Clarified and expanded the discussion of effects of tussock moth outbreaks.

Clarified and expanded the discussion of effects on non-target Lepidoptera.

Clarified and expanded the discussion of effects on wildlife that eat moths and butterflies.

INTRODUCTION

This chapter provides the scientific and analytical basis for the comparison of alternatives displayed in Chapter II. It discusses the direct, indirect, and cumulative environmental effects of the Proposed Action and all alternatives. Environmental affects result when changes are made to ecosystems. Changes may occur either by implementing an action or by choosing to exclude all or some areas from action. Information that is more detailed can be found in the analysis file, available upon request.

FOREST HEALTH

All of the alternatives considered would leave some host type unprotected. In host type stands that are not protected during a tussock moth outbreak, varying levels of defoliation and mortality would be expected. This would depend on physical factors (elevation and aspect), and biological factors (amount of host type, stand structure, tussock moth reproduction and bark beetle activity). Insect outbreaks are generally defined as "minor disturbances", in the sense that some trees remain alive. This distinguishes them from "major disturbances", such as glaciers or severe stand replacing fires (Oliver and Larson 1990).

Experience from the 1972/1973 Outbreak

In the early 1970s outbreak, about 700,000 acres were defoliated to some degree by Douglas-fir tussock moth. The severity of defoliation varied from light to heavy with tracts of up to 1000 acres of 100% dead trees. The degree of defoliation was surveyed and classified as follows (USDA Forest Service, 1974):

- Σ Dead – 100% mortality. This occurred in areas of up to several hundred acres in size. This category included about 17,490 acres.
- Σ Severe defoliation – over 50% of the area had trees with 100% defoliation. These areas had about 75% mortality. This category included about 62,800 acres.
- Σ Moderate defoliation – over 50% of the area had trees with at least the top quarter of the crown completely defoliated. These areas had about 10% mortality and included about 279,820 acres.
- Σ Light defoliation – this had two parts, the first where the defoliation was visible from the air and had less than a quarter of the crowns defoliated and the second where defoliation was not visible from the air. In these areas, mortality was scattered, but was close to zero percent.

Current Predictions

If the outbreak proceeds as expected, unprotected areas would have various levels of change in stand structure, stand density, and species composition. These changes would be most pronounced in high-risk stands with 60-100% host type and dense or medium crown closure. In the short term, defoliation could reduce crown closure below 20%. Some defoliated trees would recover.

Mortality could reduce crown closure by an average of one class until sites reforested and reestablished crown closure (dense crown closure would be reduced to medium and medium would be reduced to low). There would be a corresponding increase in the number of snags, which could be beneficial to snag-dependent wildlife. For purposes of this analysis, estimates of defoliation and mortality for moderate-risk sites are considerably lower than estimates for high-risk sites. However, in 60-100% host type, moderate-risk sites with dense crown closure could also experience substantial defoliation if the outbreak becomes severe.

Stands that experience heavy mortality in host species and that have adequate pine seed source would have more pine regeneration. In the absence of ground fire or silvicultural treatment, true fir and Douglas-fir would remain the dominant tree species in most stands (Wickman, et. al., 1986). As snags fall, increasing fuel loads could make the area subject to stand-replacing wildfire.

Host trees that survive defoliation would experience several years of reduced growth, followed by long term growth increases (Wickman and Starr, 1990).

NO ACTION

No stands would be protected from tussock moth defoliation. Varying levels of defoliation and mortality would be expected. The acres of host type by risk rating and crown closure for each Forest were displayed in Chapter III. Stands with dense crown closure and a high risk of outbreak are generally dry, overstocked sites, with low vigor and high susceptibility to a variety of forest pests and pathogens. The highest mortality and most pronounced changes in structure would occur in these stands.



Figure IV-1: Effects of Defoliation

High Risk Stands

Defoliation of 60-100% is expected, with 25 - 95% direct mortality (average = 48%). Mortality would take place over the duration of the outbreak. Bark beetles would be attracted to trees stressed by defoliation. Douglas-fir beetles would attack Douglas-fir, fir engravers would attack grand fir, and western balsam bark beetles would attack subalpine fir. Bark beetle mortality would probably continue for three years after tussock moth mortality (Wickman, 1963). If bark beetles are already active in the area, total mortality in trees larger than 14" dbh could average 70%. Smaller trees, less attractive to bark beetles, would have average mortality of 50%. This could create a late stand initiation stage, where growing space is not fully occupied and new stems become established in openings.

Where bark beetles are not already active, beetles would be attracted to the area. Total mortality would probably increase to 61% for trees larger than 14" dbh and 22% for smaller trees. Although total mortality would be less than in active bark beetle areas, it would still create sufficient openings to develop late stand initiation stage conditions.

Moderate-Risk Stands

Expected defoliation is 40-60% of host species, with 5% direct mortality in trees of all size classes. If bark beetles are already active in the area, total mortality in trees larger than 14" dbh would average 25%; 7% in smaller trees. In addition to mortality, the tops of 10-25% of the host trees would die. In 60-100% host type stands, the combined effects of direct and indirect mortality could be sufficient to move some stands to a late stand initiation stage. Where bark beetles are not already active, some bark beetle mortality is still expected. Total mortality in trees larger than 14" dbh would average 12%. There would be little/no additional mortality in smaller trees. Ongoing stand dynamics would probably not be affected. In 20-60% host type stands, even the highest expected level of mortality would not have a substantial effect on stand dynamics.

Low-Risk Stands

Defoliation in low risk stands would probably be 10-40%, with little mortality unless bark beetles are active in the area. No change in stand dynamics is expected.

Cumulative Effects: The 1997 Interior Columbia Basin Ecosystem Management Project Draft EIS included recommendations for management of dry site forests. National Forests east of the Cascades have used these recommendations to design projects on dry sites. The Wenatchee, Wallowa-Whitman, and Umatilla Forests have developed specific strategies for restoration of dry sites. The Wenatchee's Dry Site Strategy sets Forest-wide priorities for thinning, under-burning, and harvest designed to improve forest health and sustainability. The Blue Mountain Demonstration Project on the Wallowa-Whitman and Umatilla National Forests is a 2.5 million acre watershed-level project. Activities would include thinning and prescribed fire to improve the health of dry sites. Because of the substantial mortality likely to occur

from the No Action Alternative, some of those other restoration strategies could be rescheduled or changed. More detail can be found in the Forest Health section of the analysis file.

The Colville, Okanogan, and Wenatchee National Forests have 84,000 acres of dense, high-risk host type. Most of this is on the east half of the Colville National Forest. If a tussock moth outbreak occurs here, additional mortality from the existing Douglas-fir beetle outbreak is expected.

There are 2,731,100 acres of host type; heavy defoliation could occur on high- and medium-risk sites. About 308,100 acres are considered high-risk, with dense crown closures of more than 60% host species. About 40,000 acres had visible tussock moth defoliation in 1999 and surveys indicate that populations are continuing to build. Tussock moth populations in eastern Oregon are volatile and the likelihood of outbreak is higher here than anywhere else in the Region (Mason, 1996).

The Winema and Fremont National Forests have a relatively small amount of dense, high-risk host type. Stands are concentrated on the west side of the Winema, near Mountain Lakes and Sky Lakes Wilderness Areas.

PROPOSED ACTION

The Proposed Action would protect areas where loss of crown cover and associated mortality could cause a loss of valuable resources. High-risk stands that are protected would continue to decline in vigor due to overstocking. Susceptibility to defoliating insects, bark beetles, and root diseases would remain high unless stocking control and species composition is changed with silvicultural treatment (Wickman, 1986). Moderate risk stands that are protected would generally maintain current rates of growth and development. Some low risk stands would be protected from defoliation to maintain crown closure in those areas. Short-term protection from defoliation would have little effect on overall stand health or development.

Cumulative Effects: Implementation of the Proposed Action would retain existing host type vegetation on about 236,000 acres of high-risk, dry forest where defoliation could result in damage to Areas of Concern. Retaining host type on these acres would be a short-term strategy until restoration efforts could be implemented. Where substantial defoliation and mortality occurs, restoration efforts might have to be rescheduled in response to changes in stand structure and fuel load.

COLVILLE, OKANOGAN, AND WENATCHEE FORESTS

There are 1,291,400 acres of host type in eastern Washington, of which 84,000 acres are dry site forests at high risk for defoliation and mortality. If the Proposed Action were implemented, 65,600 of these dry site acres would not be protected.

On the Colville National Forest, 7,200 acres would be protected from defoliation. This includes 900 acres of dry site, dense forest. All of these are high-use recreation or residential areas, including the City of Ione, Sullivan Lake,

Swan Lake Recreation Enclave, and several other campgrounds.

On the Okanogan National Forest, about 122,000 acres would be protected. This includes 7,600 acres of dry site, dense forest. Protection areas are scenic highway corridors, late/old stand structures with important habitat values, and Wilderness areas and Late Successional Reserves that are at high risk of wildfire.

On the Wenatchee National Forest, about 95,600 acres would be protected from defoliation, including 9,900 acres of dry site, dense forest. Most of this is spotted owl nesting, roosting or foraging habitat.

UMATILLA, W-W, MALHEUR, AND OCHOCO FORESTS

In the event of an outbreak, 389,100 acres would be protected from defoliation. This includes 97,300 acres of dry site, dense forest. 210,800 acres of high-risk dry sites would not be protected. In addition, 1,424,900 acres of medium-risk sites and 407,800 acres of low-risk sites would be unprotected.

On the Umatilla National Forest, 135,300 acres would be protected from defoliation, including 53,000 acres of dry site, dense forest. These areas are important late/old structure habitats and high use recreation sites.

On the Wallowa-Whitman National Forest, 110,600 acres would be protected from defoliation, including 31,500 acres of dry site, dense forest. These areas are important late/old structure habitats and high use recreation sites. They also include two municipal watersheds

On the Malheur National Forest, 73,300 acres would be protected from defoliation, including 5,800 acres of dry site, dense forest. These areas are important late/old structure habitats, fish streams, and scenic viewsheds.

On the Ochoco National Forest, 69,900 acres would be protected from defoliation, including 7,000 acres of dry site, dense forest. These areas are important late/old structure habitats, fish streams, high use recreation sites, and scenic viewsheds.

WINEMA AND FREMONT NATIONAL FORESTS

On the Winema National Forest, 24,600 acres would be protected from defoliation. Very little of this is on dry site, dense forest. The habitat of a rare alga, a 600 acre block around Mare's Egg Spring, and 24,000 acres of spotted owl habitat in the Chiloquin Ridge area would be protected.

On the Fremont National Forest, one bull trout reach (200 acres) would be protected if an outbreak occurs. This site would experience no change in current stand structure, growth rate, or overall forest health. Of the remaining 11,600 acres, all are considered moderate to low risk for defoliation because crown closures are less than 70%. Although defoliation risk is not high, up to 4,200 acres of stands dominated by host type could have mortality of 5-10%, with an additional 10-25% of the trees top-killed. This is a higher mortality rate than would occur under normal levels of insect and disease, but it would not affect

succession or overall forest health. If defoliation occurs in mixed species stands, mortality would be only 1-2%. This is the same or slightly higher than expected under normal insect and disease levels. Overall, forest health and succession would not be affected.

EXPANDED PROTECTION ALTERNATIVE

In addition to areas considered in the Proposed Action, all 60-100% host type outside Wilderness would be protected to prevent defoliation. Dense host type forests on dry sites could continue to experience declining vigor. Susceptibility to defoliating insects, bark beetles, and root diseases would remain high. One of these disturbance agents or wildfire would eventually remove most host type, could reduce short term crown closure, and could result in regeneration of both host and non-host species (Wickman, et. al., 1986). Non-host species are mostly early seral, such as ponderosa pine and larch. These might increase after the outbreak. However, unless measures are taken to reduce stocking of naturally-regenerated host species, tussock moth host species would eventually out compete pines and larches, starting the cycle over again.

Cumulative Effects: Protection could prevent defoliation of overstocked dry sites. Planned restoration projects could proceed. No changes in scheduling or emphasis would be required due to defoliation and mortality.

TM-BIOCONTROL ONLY

The effects of TM-BioControl Only alternative would be similar to the Proposed Action. In the unlikely event that an outbreak occurred on every acre identified for protection, existing supplies of the insecticide would be used to protect the highest priority sites. Up to 262,000 acres of lower priority scenic view and late/old structure could be defoliated.

FOREST ENVIRONMENT: LATE SUCCESSIONAL RESERVES

NO ACTION

EASTERN WASHINGTON CASCADES PROVINCE

No host type stands would be protected from defoliation. In the event of an outbreak, there would be a potential for heavy defoliation and mortality in Upper Methow, Nice, Twisp River and Sawtooth LSRs on the Okanogan, and Lucerne, Shady Pass, Chiwawa, Natapoc, Deadhorse, Eagle, Boundary Butte, Sand Creek, Swauk, and Teanaway LSR/MLSRs on the Wenatchee. This could include most of the late/old structure in the Nice and Twisp River LSRs, and about half of the late/old structure in Teanaway LSR. Areas of heavy mortality would lose their old growth character, and would enter a stand initiation stage. The additional fuel load would increase the risk of stand-replacing wildfire.

If severe defoliation occurs in areas of 20-60% host type, there would be reduced inter-tree competition. As a result, non-host species could have increased growth.

YAKIMA PROVINCE

There would be a potential for heavy defoliation and mortality in the Manastash LSR, which has substantial acreage of 60-100% host type. Most of this would be in the moist grand fir plant community. Risk of outbreak is moderate in this community type, but under outbreak conditions, there can be substantial damage to host trees. These acres could lose their late/old structure, and enter a stand initiation stage.

EASTERN OREGON CASCADES PROVINCE

No host type stands would be protected from defoliation. In the event of an outbreak, there would be a potential for heavy defoliation and areas of mortality in LSRs 227, 228 and 229 on 35,000 acres. This could include most of the old growth in LSRs 227 and 228, about 17,000 acres. Areas of heavy mortality would lose their old growth character, and would enter a stand initiation stage. The additional fuel load would increase the risk of stand-replacing wildfire.

An additional 16,000 acres with 20-60% host type could have defoliation and mortality. These stands would have

reduced inter-tree competition, and non-host species would have increased growth.

PROPOSED ACTION AND TM-BIOCONTROL ONLY ALTERNATIVE

EASTERN WASHINGTON CASCADES PROVINCE

Some of the host type stands in Upper Methow, Nice, Twisp River, Sawtooth, Chiwawa, Boundary Butte, and Teanaway would be protected from defoliation. All of the host type stands in Lucerne, Shady Pass, Natapoc, Deadhorse, Eagle, Sand Creek, and Swauk would be protected. These areas would have no change in stand dynamics because of defoliation. There could be substantial losses of late/old structure in the Sawtooth and Teanaway LSRs, where several thousand acres of 60-100% host type would not be protected. Protected areas in the dry plant association groups would continue to decline in vigor unless silvicultural treatments are implemented.

Table IV-1: E. WA Cascades Province - Protection Summ. for Proposed Action & TM-BioControl Alt.

NAME	LATE/OLD PROTECTED 60-100%	LATE/OLD NOT PROTECTED 60-100%	LATE/OLD PROTECTED 20-60%	LATE/OLD NOT PROTECTED 20-60%	YOUNG TO MATURE PROTECTED 60-100%	YOUNG TO MATURE NOT PROTECTED 60-100%	YOUNG TO MATURE PROTECTED 20-60%	YOUNG TO MATURE NOT PROTECTED 20-60%
Boundary Butte	100	100	300	600	0	100	100	400
Chiwawa	2,200	300	2,800	600	2,400	200	2,200	400
Nice	400	200	400	100	600	200	500	100
Sawtooth	900	3,200	300	2,500	2,100	6,400	900	3,600
Teanaway	2,700	6,500	0	0	0	0	0	0
Twisp River	3,700	1,000	2,500	400	7,600	1,900	4,700	700
Upper Methow	5,900	5,600	2,500	800	10,300	10,000	4,200	1,400

Table IV-2: Yakima Province - Protection Summary for Proposed Action or TM-BioControl Alternatives

NAME	LATE/OLD PROTECTED 60-100%	LATE/OLD NOT PROTECTED 60-100%	LATE/OLD PROTECTED 20-60%	LATE/OLD NOT PROTECTED 20-60%	YOUNG TO MATURE PROTECTED 60-100%	YOUNG TO MATURE NOT PROTECTED 60-100%	YOUNG TO MATURE PROTECTED 20-60%	YOUNG TO MATURE NOT PROTECTED 20-60%
Haystack	1,700	0	3,600	0	500	0	600	0
Lost Lake	200	0	2,100	0	0	0	500	0
Manastash	3,800	12,100	0	0	0	0	200	0
Russell Ridge	1,100	0	700	0	200	0	300	0
Tieton	100	100	100	100	0	0	0	0

YAKIMA PROVINCE

Some of the host type stands in the Manastash and Tieton LSRs would be protected from defoliation. All of the host type stands in the Haystack, Russell Ridge and Lost Lake MLSRs would be protected. These areas would have no change in stand dynamics because of defoliation. About 12,100 acres of 60-100% host type, the late/old structure in the Manastash LSR, would not be protected and could enter the stand initiation stage.

EASTERN OREGON CASCADES PROVINCE

The effects are the same as the No Action alternative.

EXPANDED PROTECTION ALTERNATIVE

EASTERN WASHINGTON CASCADES PROVINCE

In addition to areas protected under the Proposed Action, all areas of 60-100% host type would be protected from defoliation. There would be no losses of late/old structure or changes in stand dynamics due to defoliation. Protected areas in the dry plant association groups would continue to decline in vigor unless silvicultural treatments are implemented.

YAKIMA PROVINCE

All areas of 60-100% host type would be protected from defoliation. There would be no losses of late/old structure due to defoliation, and no changes in stand dynamics.

EASTERN OREGON CASCADES PROVINCE

All host type stands with 60-100% host type would be protected. There would be no changes in structure, old growth character, or wildfire risk because of defoliation.

FOREST ENVIRONMENT: OLD-GROWTH/LOS

NO ACTION

High-risk areas with dense crown closure and 60-100% host type could have the most dramatic changes in stand structure. In the event of an outbreak, these areas are likely to be heavily defoliated with significant mortality. Late/old structure could be lost and the stands could enter the late stand initiation stage. If outbreak conditions are severe, old growth function could be at risk wherever tussock moth host species are dominant. Risk of stand-

replacing fire would be very high during the year(s) of defoliation. Where defoliation results in mortality, long term fire risk would increase. Fire spread could result in the loss of adjacent late/old structures, even those without severe insect mortality. On some Forests, there could be sudden, substantial increase in fuels. Stands of less than 60% host type could have reduced crown closure and changes in structure, but old growth function would probably not be lost.

COLVILLE, OKANOGAN, AND WENATCHEE FORESTS

On the Colville, 5% of the Forest's old growth would probably lose function due to defoliation and mortality. Another 60% is dominated by host type, and could be at risk to lose old growth function in a severe outbreak. These changes would be most evident on the west half of the Forest.

On the Okanogan, 3% of the Forest's old growth would probably lose function due to defoliation and mortality. All of this is in Late Successional Reserves. Another 30% is dominated by host type and would be at risk to lose old growth function in a severe outbreak. This includes 10 spotted owl activity centers.

On the Wenatchee, less than 1% of the Forest's old growth would probably lose function due to defoliation and mortality. Another 2% is dominated by host type, at risk to lose old growth function in a severe outbreak. Although this is a small portion of the Forest's total old growth, it includes 20 spotted owl activity centers.

UMATILLA, W-W, MALHEUR, AND OCHOCO FORESTS

Historic information and current insect surveys indicate the highest tussock moth populations are, and will continue to be, in eastern Oregon.

On the Umatilla, 25% of the Forest's old growth would probably lose function due to defoliation and mortality. This would include portions of the single largest contiguous stand of old growth on the Forest. Another 30% is dominated by host type, at risk to lose old growth function in a severe outbreak.

On the Wallowa-Whitman, 10% of the Forest's old growth would probably lose function due to defoliation and mortality. Another 30% is dominated by host type, at risk

to lose old growth function in a severe outbreak. Stands throughout the Forest could be affected.

On the Malheur, 7% of the Forest's old growth would probably lose function due to defoliation and mortality. Another 50% is dominated by host type and would be at risk to lose old growth function in a severe outbreak. This could include stands throughout all old growth habitat areas.

On the Ochoco, 10% of the Forest's old growth would probably lose function due to defoliation and mortality. Another 30% is dominated by host type, at risk to lose old growth function in a severe outbreak. This could cause noticeable changes in old growth distribution throughout the Forest since the north half would be most severely affected.

WINEMA AND FREMONT NATIONAL FORESTS

On the Winema, 6% of the Forest's old growth would probably lose function due to defoliation and mortality. All of this is in Late Successional Reserves. Another 10% is dominated by host type, at risk to lose old growth function in a severe outbreak. There is no old growth at risk for tussock moth defoliation on the Fremont.

PROPOSED ACTION

Each Forest has identified areas where defoliation or mortality would substantially degrade one or more resource values. The Proposed Action includes protection of some late/old structure on every Forest as part of these Areas of Concern.

Some potentially protected stands are "high risk", with multi-storied structure and dense crown closure. These are generally overstocked, dry sites. Vigor would continue to decline on these sites. Defoliation in unprotected stands, including OG/LOS, could result in vegetation changes. These areas would probably not lose old growth function, even with some mortality. Stands with a low percentage of host type could also be protected because they are surrounded by areas dominated by host type and it is impractical to avoid them.

COLVILLE, OKANOGAN, AND WENATCHEE NATIONAL FORESTS

On the Colville, 118,500 acres of old growth are dominated by host type, with 8,600 at high risk for loss of function. This includes 7,000 acres in the Salmo-Priest Wilderness. These areas are not presently providing unique habitat, or habitat for threatened or endangered species. None of these acres would be protected from defoliation. If maximum defoliation were to occur, 48,400 acres of non-host old growth and 8,800 acres of mixed species old growth would retain function. Potential effects would be the same as the No Action Alternative.

On the Okanogan, 65,700 acres of old growth are dominated by host type, with 6,000 at high risk for loss of function. Thirty percent of these acres would be protected from defoliation, including 2,600 acres at high risk for loss of function. An additional 8,200 acres of 20-60% host

type would be protected. Most of these areas are in Late Successional Reserves and are providing important old growth habitat. Where host type is 60-100%, protection areas were identified based on need to prevent large-scale fire. In the Pasayten Wilderness, 1,200 acres would not be protected.

On the Wenatchee, 15,800 acres of old growth are dominated by host type, with 3,500 at high risk for loss of function. Sixty percent of these acres would be protected from defoliation, including all acres at high risk for loss of function. An additional 13,000 acres of 20-60% host type would be protected. All of these areas are in Late Successional Reserves. They are providing important old growth habitat and are at high risk for wildfire. Old growth that would not be protected includes 2,300 acres in Wilderness areas, mostly in Lake Chelan-Sawtooth.

UMATILLA, WALLOWA-WHITMAN, MALHEUR, AND OCHOCO NATIONAL FORESTS

On the Umatilla, 18,300 acres of old growth are dominated by host type, with 8,300 at high risk for loss of function. Eighty percent of these acres would be protected from defoliation, including all of the acres at high risk for loss of function. An additional 4,000 acres of 20-60% host type would be protected. These areas contain important habitat for fish and old growth dependent wildlife. Old growth that would not be protected includes 1,300 acres in the Wenaha-Tucannon Wilderness.

On the Wallowa-Whitman, 210,700 acres of old growth are dominated by host type, with 51,300 acres at high risk for loss of function. One-third would be protected to prevent degradation of fish habitat, raptor nest sites, scenic corridors, and the Baker City and City of Sumpter municipal watersheds. This would include 12,300 acres at high risk for loss of function. An additional 32,800 acres of 20-60% host type would be protected to preserve recreation values. Old growth that would not be protected includes 133,200 acres in Wilderness areas, primarily Hells Canyon and Eagle Cap.

On the Malheur, 149,100 acres of old growth are dominated by host type, with 18,300 at high risk for loss of function. Twenty percent of these acres would be protected from defoliation, including 5,000 acres at high risk for loss of function. An additional 8,700 acres of 20-60% host type would be protected. All of these are in unique habitat areas (see Chapter III). Old growth that would not be protected includes 13,200 acres in the Strawberry Mountain and the Monument Rock Wilderness Areas.

On the Ochoco, 31,700 acres of old growth are dominated by host type, with 7,700 at high risk for loss of function. Ninety percent of these acres would be protected from defoliation, including 7,000 acres at high risk for loss of function. An additional 34,400 acres of 20-60% host type would be protected. This would include stands containing residential and administrative sites, high use recreation areas, and the Mitchell municipal watershed. Old growth

that would not be protected is in Mill Creek, Bridge Creek, or Black Canyon Wilderness Areas.

WINEMA AND FREMONT NATIONAL FORESTS

On the Winema, 38,400 acres of old growth are dominated by host type, with 14,500 at high risk for loss of function. These areas are in the Sky Lakes and Mountain Lakes Wildernesses; they would not be protected. Most of these areas would not be protected. About 8,700 acres of 20-60% host type would be protected to prevent degradation of spotted owl activity centers.

There is no old growth at risk of defoliation on the Fremont; no OG/LOS stands would be protected.

EXPANDED PROTECTION ALTERNATIVE

In addition to areas identified under the Proposed Action, all late/old structure outside of Wilderness with 60-100% host type would be protected from defoliation. Stand dynamics would not change because of tussock moth defoliation.

TM-BIOCONTROL ONLY ALTERNATIVE

Potential effects are the same as the Proposed Action.

FIRE

Long-term fuel increase and subsequent changes in fire intensity and severity could result from a tussock moth outbreak. Fire behavior is based on stand density, stand composition, the amount and arrangement of surface fuels, moisture content, prevailing weather, and physical setting. Fire severity partly depends on fire behavior, varying by the duration of burning, the season, and site or stand conditions.

Tussock moth outbreaks can increase fire hazard in several ways. Large quantities of fine, dead fuels remain in tree crowns for several months to two years after defoliation. Other small diameter fuels can remain in the crowns for five years (Beukema, et. al., 1999). The effect on susceptibility of trees to crown fires is uncertain since crown mass decreases with defoliation (Agee, 1996) but the ratio of dead to live fuels increases (Zimmerman, pers. comm., 2000). Crown moisture, which can be much lower for dead foliage than live needles, influences the threshold at which crown fires can occur (Van Wagner, 1977).

The amount and distribution of surface fuel affects crown fire potential and the spread and intensity of surface fires. Surface fire hazard and the probability of crown fires increase when there is an accelerated build-up of fuels (i.e., needles, twigs, branches, and broken tops). Initially, a large amount of smaller diameter material from defoliated crowns becomes potential fuel. Larger diameter fuels (e.g., limbs over 3" in diameter) accumulate as surface fuel for about 15 years. The quantity and composition of surface fuels depends on the rate the materials fall from the dead trees, the decomposition rate, successional patterns of understory vegetation, species composition of the overstory, and previous history of the stand. With this accumulation of dead fuel, the increase in

downed woody material far exceeds decay for several decades. After 10 to 15 years, surface fires could climb into the crowns of affected stands that have large amounts of downed material and fuel ladders.

The open canopies caused by defoliation also result in warmer, drier microclimates at the surface during daylight hours. Defoliated trees permit increased sunlight at the forest floor and higher wind speeds. Eventually, the opened canopy would foster the growth of sunlight-dependent shrubs, herbs, forbs, and grasses. This new growth on the forest floor could retard fire spread when the vegetation was moist. However, under drought conditions, the new growth could become an additional fuel, increasing the spread and intensity of a fire. Since these stands would have more grass and brush than a denser stand, spread rates might resemble a grass or brush fuel type. Predicted changes in fire behavior (Table IV-3, below) were derived using the BEHAVE model. Weather and fuel moisture conditions were kept constant to demonstrate the effects of changing fuel conditions (i.e., varying fuel models due to defoliation). Two sets of values were used for calculations. The first set represents fuel conditions commonly found during normal summers in the inland Northwest and the second set represents fuel conditions commonly found during drought conditions (NWCG, 1992). Not surprisingly, differences between fuel models are more pronounced during drought conditions.

Table IV-3: Fire Behavior

FUEL MODEL	RATE OF SPREAD NORMAL/DROUGHT (FEET/HOUR)	FLAME LENGTH NORMAL/DROUGHT (IN FEET)
2 - Short grass/Pine	1,650 / 1,112	5.3 / 6.3
5 - Deciduous brush	726 / 1,782	3.4 / 6.7
6 - Sagebrush/litter	1,848 / 2,244	5.6 / 6.4
8 - Short needle conifer litter	132 / 132	1.0 / 1.2
10 - Heavy short needle conifer litter	462 / 660	4.5 / 5.7
11 - Light slash	396 / 462	.4 / 3.7
12 - Medium slash	858 / 990	7.9 / 9.0

Snags from defoliated trees might persist for several decades. The presence of snags and large branches would probably affect fire severity and the duration of burning, not fire intensity. Larger materials require a much longer period of fire, which in turn, allows more heating of residual trees and the soil. The increased amount of fuel puts these areas at risk for uncharacteristic fire severity, which can lead to loss of organic matter, woody material, and nutrient reservoirs. This is especially true in drier environments where fire frequency is high (Harvey, et. al., 1994). Nutrients, such as nitrogen, can be evaporated by fire. This can result in an immediate loss of soil productivity and can limit future inputs of nutrients. Nutrients, such as carbon, become more available by fire,

by converting large woody debris into smaller, more readily decomposed material (DeBano, 1981, cited in USDA & USDI, 2000).

Refer to the Forest Health effects section for a description of defoliation categories of the early 1970's outbreak and an estimated acres of defoliation based on that outbreak. During that outbreak, about 700,000 acres were defoliated by Doug-fir tussock moth.

Table IV-4 is derived from the early 1970s outbreak experience.

The dead and severe defoliation categories generally result in the highest increase in fuels with a corresponding increase in the risk of ignition and rate of spread. Moderate defoliation would increase fuels significantly and would be more likely to carry a crown fire than severe defoliation. Light defoliation contribution to fuels and risk is minimal.

Defoliation in 1973 was in widely scattered clusters, a pattern expected in future outbreaks. The spatial distribution of the intensity of the outbreak, however, cannot be predicted. The actual location of the defoliation would be vital in determining the potential impact on forest stand structure and dynamics, and hence on altering the level of fire risk. If heavily impacted stands were distributed evenly throughout the total outbreak area, the overall impact on fire risk would be relatively small. Impacts at the stand level could be rather significant, as discussed above. However, maps of the 1970s outbreak reveal larger patches of heavy damage evident at the landscape scale, rather than at the stand scale. Some large patches that affected watersheds were close to numerous other large patches. These affected broad landscapes and sub-basins. Wildfires in these patches could become very large due to the additional fuel accumulations from defoliation, stand density, changes in microclimate (i.e., increased exposure to sun and wind). The majority of

large fires in these Forests over the past two decades have occurred as multiple, high-intensity events. In the Blue Mountains, 44% burned at a high level of severity, compared to only 5% in the previous century (Johnson, 1998). Defoliation of extensive forest areas by Douglas-fir tussock moth could exacerbate the already significant challenge of reducing fuels and restoring ecosystems on a landscape scale.

NO ACTION ALTERNATIVE

This alternative would result in the highest fuel increase during the next 15 years. Based on the early 1970's outbreak experience, we could expect the most severe defoliation (and fuel buildup) on about 12 % of the outbreak area. About 40% of that area would have moderate defoliation. Surface fuel increases could affect fire intensity for two decades; effects of increases in ladder fuels would continue longer. Fire severity would increase for several decades or until the first severe fire.

PROPOSED ACTION AND TM-BIOCONTROL ONLY ALTERNATIVE

The Proposed Action and TM-BioControl alternatives would protect about 15% of the acres of the area in the No Action Alternative (the No Action alternative consists of areas between 20% and 100% host type) and would likely reduce overall severe and moderate defoliation proportionately. The key is that the specific identified areas as described in the Proposed Action (T&E habitat, Municipal Watersheds, Old Growth and Late Old Structure areas, etc.) would be protected with a subsequent prevention of increased fire risk in those areas.

EXPANDED PROTECTION ALTERNATIVE

This alternative would protect more than half of all host type, and nearly all of the 60-100% host type. The would prevent an increase in fuels and fire risks.

Table IV-4: Summary of Expected Defoliation, in acres

ALTERNATIVE	100% MORTALITY	SEVERE DEFOL.	MOD. DEFOL.	LIGHT DEFOL.	TOTAL
No Action	17,490	0	0	0	17,490
Proposed Action & TM-BioControl Only	13,880	0	0	0	13,880
Expanded Protection	5,270	0	0	0	5,270

SEED ORCHARDS

NO ACTION

ALL FORESTS

None of the orchards would be protected. Although small Douglas-fir trees are less susceptible to bark beetles than large trees, they generally suffer more mortality from the direct effects of defoliation (Wickman, 1963). The exception is small seedlings with no overstory, which lacks tussock moth habitat (4 orchards on the Wallowa-Whitman). All other Douglas-fir orchards are susceptible. Defoliated orchard trees would probably have average mortality of 48%. This would necessitate replanting – a considerable expense plus the loss of years already invested in growing the trees.

These seed orchards were established to provide a source of seed from parent trees known to be vigorous under local conditions. The parent trees grew more rapidly than their neighbors, had good form, and produced seedlings with good juvenile survival. If the orchards are unable to provide future seed because of tussock moth mortality, or if seed production is delayed due to growth losses from defoliation, the benefits of parent tree selection and breeding could be lost or delayed.

PROPOSED ACTION

ALL FORESTS

This alternative would protect all susceptible seed orchards. When considered in combination with past, present, and reasonably foreseeable future actions, there would be no cumulative effect from implementing this alternative.

EXPANDED PROTECTION ALTERNATIVE

ALL FORESTS

This alternative would protect all susceptible seed orchards. When considered in combination with past, present, and reasonably foreseeable future actions, there would be no cumulative effect from implementing this alternative.

TM-BIOCONTROL ONLY ALTERNATIVE

ALL FORESTS

This alternative would protect all susceptible seed orchards. When considered in combination with past, present, and reasonably foreseeable future actions, there would be no cumulative effect from implementing this alternative.

WATER QUALITY: DEFOLIATION EFFECTS

The primary affects to water quality from a tussock moth outbreak would be from changes in stream temperature,



sedimentation, or nitrogen levels. Temperature is the most common water quality concern for all water bodies in the Pacific Northwest. Defoliation of stands adjacent to streams can result in more sunlight reaching the water. Potential changes in temperature depend on the degree of defoliation, the orientation of the stream, the volume of water in the stream, adjacent topography, and channel characteristics. The potential to raise stream temperature is also related to the length of stream that passes through an area of greater than 60% host type. There is a substantial probability that localized stream temperature would increase if a 60-100% host type stand were completely defoliated. Lesser amounts of defoliation can also alter stream temperature but it is unlikely partial defoliation of 0-60% host type stands would increase temperature to a level that is statistically significant.

Sedimentation is a function of many variables: soil characteristics, geology, topography, vegetative cover, and whether the area is susceptible to peak flow events. Defoliation effects on rain-on-snow or snowmelt processes are small. This is because tree boles and limbs remain after defoliation. Canopy and airflow dynamic interactions that affect snow accumulation or melt rates are not expected to change significantly in defoliated areas. Although defoliation could change the vegetative cover, which could have some affect on sedimentation, the expectation is that it would not be significant. Stand defoliation would probably not increase surface erosion or sedimentation even if it occurred on large tracts of land in areas of more than 60% host type.

Changes in nitrogen levels in water bodies could result from the direct introduction of insect frass or through decay and assimilation of organic materials. Streams that currently exceed water quality standards for nitrogen are linked to fertilizer use and septic systems. It is not likely that defoliation or needle decay would result in measurable changes in nitrogen levels of any form of nitrogen.

Other water quality variables are not considered to be substantially or significantly at risk of change as the result of defoliation of host type. While changes in temperature could result in some change in dissolved oxygen levels and perhaps, the level or diversity of aquatic organisms, such changes are expected to be immeasurable. Small changes in pH could result from changes in temperature or aquatic organisms; this change is expected to be immeasurable. Changes in stream flow or aquatic habitat from defoliation or treatment of stands are expected to be immeasurable. Any changes in stream-flow from defoliation would not be detectable at the watershed or sub-watershed scales. Although changes in tree vigor in response to insects and defoliation could have an effect on transpiration and, hence, on water yield, these changes would be immeasurable. Channel morphology, habitat complexity, and localized stream characteristics could be altered by an increase in downed woody debris from defoliation. It would be impractical to predict the impacts as to size, quantity, and configuration of this debris because the exact location of defoliation is not predictable.

The secondary effect of most concern is the increased risk of fire and severity of fire. If severe or moderate defoliation occurs, fuel availability, risk of ignition, and risk of larger fires increases. If fire does occur after defoliation, there would be an increase in sedimentation. The exposure of bare soil to rain-on-snow events can change dramatically.

As stated above, defoliation along streams is just one factor that could contribute to stream temperature increases. Protection of the streamside areas (for out to 300 feet on each side of the stream) is therefore a factor that could result from a tussock moth outbreak and is measurable. Significant environmental effects would be in areas with 60-100% host type. The following table displays the unprotected acres and miles of streams for each alternative.

NO ACTION ALTERNATIVE

About 4,750 miles of streams would be unprotected in 60%-100% host type. The number of miles in host type are in indication of the risk of defoliation, and hence the risk of an increase in stream temperature. There is no significant effect expected on nitrogen levels or sedimentation from defoliation only. The secondary effect is the increased risk of fire and severity of fire. If severe or moderate defoliation occurs, fuel availability, risk of ignition, and risk of larger fires increases. If fire does occur after defoliation, there would be an increase in sedimentation.

PROPOSED ACTION

About 942 miles of streams with 60%-100% host type would be protected. That leaves about 5,700 miles unprotected. The potential for defoliation that could cause increased temperature in streams is less than the No Action alternative but the opportunity is still significant. The risk

of fire described in the No Action alternative is less, but is still therein unprotected areas. However, the Areas of Concern as described in the Proposed Action would be removed from an increased risk.

EXPANDED PROTECTION ALTERNATIVE

About 4,990 miles of streams with 60%-100% host type would be protected. Around 710 miles would be left unprotected. This significantly reduces overall exposure for defoliation caused temperature increases and the risk of increased sedimentation from possible increased risk of fire.

TM-BIO-CONTROL ONLY ALTERNATIVE

The effects are the same as the Proposed Action.

Table IV-5: Streams with >60% Host Type

FOREST	NO ACTION ALT.		PROPOSED ACTION & TM-BIOCONTROL ALT.		EXPANDED PROTECTION ALT.	
	UNPROT. ACRES	UNPROT. MILES	UNPROT. ACRES	UNPROT. MILES	UNPROT. ACRES	UNPROT. MILES
Colville	582,240	1099	575,420	1,086	21,800	36
Okanogan	373,620	742	290,900	560	26,570	91
Wenatchee	77,980	159	37,520	81	5,840	13
Umatilla	606,300	1437	515,210	1,083	165,530	343
W-W*	498,270	1277	429,580	1,105	60,530	135
Malheur	335,450	815	87,950	739	29,000	64
Ochoco	41,780	86	11,980	20	5,340	8
Winema	69,020	80	68,580	80	20,470	17
Fremont	1,370	2	980	0	950	0
Total Unprotected Acres	2,586,030		2,018,120		336,030	
Total Unprotected Stream Miles		5,697		4,754		707

WATER QUALITY: EFFECTS OF TUSSOCK MOTH & INSECTICIDE

Actual effects of increased Douglas-fir tussock moth larvae in the water are not known. The high densities of caterpillars during an outbreak increase significantly as larvae search for food. Some fall into water. In addition, the larvae produce a large amount of fecal matter. During heavy defoliation, water quality could be affected by direct contamination with frass. However, no adverse effects on human health have ever been reported from streams in infested areas. Eventually, most larvae die from the natural virus as the outbreak runs its course. Dead larvae fall into streams, introducing the virus to the water. No adverse human health effects are expected from either larval frass or the virus.

EFFECTS OF B.T.K. ON WATER QUALITY

Some of the proposed protection areas are along streams and bodies of water. These sites were usually selected to protect existing habitat and vegetation from defoliation. Insecticide application along streams could result in some spray deposited directly into the water. Insects feeding in the forest canopy directly over these water bodies could also introduce larvae, fecal matter, and virus directly into the water. In two studies, viable B.t.k. spores were found in rivers, 13 days and 4 weeks, respectively, following spraying (cited in USDA, 1995). For the DFTM project, B.t.k. would be applied at a rate of 64 – 96 oz. per acre. Any amount reaching water would be diluted and reduced significantly. The concentrations that would reach the water through aerial application would not affect water quality.

EFFECTS OF TM-BIOCONTROL ON WATER QUALITY

Water quality would probably not be affected by treatment with TM-BioControl either. The virus is persistent and able to survive for long periods under a variety of conditions. Virus lasts longer dry than wet, but in general, water does not affect survival, especially for short-term exposures of less than 30 days (Ignoffo, 1992, cited in USDA, 1995). Although the virus could survive in water, it is species specific and would have no effect on water quality. As with B.t.k. the small amounts that might reach water would be diluted quickly in running streams. In addition, the TM-BioControl risk assessment determined that application of TM-BioControl would introduce only 3% more virus to the environment than would occur during a normal outbreak (SERA, 1999).

FISH & WILDLIFE: THREATENED AND ENDANGERED SPECIES INCLUDED IN PROJECT OBJECTIVES

As stated in the Purpose and Need (Chapter I), protection of the habitats of anadromous fish, bull trout, spotted owls, and bald eagles were included in the Project Objectives. The potential effects of each alternative on these species are discussed in detail below. Effects on other threatened and endangered species are discussed in the next section (page IV-27).

Overview: Effects of defoliation on Riparian Areas

Potential Temperature Changes as Related to a Tussock Moth Outbreak: Streamside vegetation is an important component of anadromous fish and bull trout habitat. It provides essential shade to streams, thereby regulating stream temperatures. Defoliation of stands adjacent to streams can result in additional sunlight reaching the water. The degree to which potential defoliation of riparian host trees may increase stream temperatures depends on many physical characteristics. This includes rate of flow, aspect, topography as a source of shade, channel width, sinuosity and other channel features, and the level of groundwater upwelling (Beschta, et. al., 1987, Beschta et. al., 1997, Brown 1972, Brown 1985, and Beschta 1987). A reduction in shade in some areas may result in increased stream temperatures, potentially causing a reduction in habitat suitability for anadromous fish and bull trout, particularly in spawning and rearing sites. This reduction in habitat suitability would most likely reduce fish usage of these areas during the periods of elevated temperatures. In other areas, a reduction in shade may cause little to no increase on the temperature of the adjacent stream reach due to topographical shading or other physical stream and landscape attributes.

Sites where tussock moth defoliation could reduce the habitat suitability for bull trout and anadromous fish are proposed for protection in this project. However, defoliation of some stands adjacent to anadromous fish and bull trout streams is not expected to cause a measurable increase in stream temperature for the following reasons:

1. Many fish-occupied streams are wide and shallow, and not dependent on riparian shading for temperature regulation.
2. The outbreak would probably be patchy and of varying intensity. On a landscape level, defoliation at low-risk sites is expected to be <40% with approximately 1% mortality; defoliation at moderate-risk sites would probably be 40-60% with approximately 5% mortality; defoliation at high-risk sites could be >60% with approximately 48% mortality. Even with some degree of defoliation, the boles of defoliated trees, non-host tree species, and understory riparian vegetation would still provide stream shade.
3. Risk of defoliation is low in some riparian stands because of their location. Douglas-fir tussock moth outbreaks are more likely in moisture-deficient stands with poor growing conditions for Douglas-fir and true firs. In eastern Oregon, outbreaks are more likely to occur on ridges.
4. Topographic features often provide more shade to streams than riparian vegetation.
5. Many threatened or endangered fish species spawn in the spring and fall when waters are naturally cold.

6. Due to the patchiness of the outbreak, moderate/high defoliation of host type would probably occur in small, discontinuous blocks along streams. At many sites, this could benefit fish habitat by providing long-term recruitment of dead woody debris to the streams.
7. Many streams stay cool by receiving an abundant amount of subsurface flow.

Sedimentation is a function of many variables including soil characteristics, geology, topography, vegetative cover, soil disturbance, and peak flow events (Bunto, et. al., 1998). Defoliation could reduce transpiration, which could potentially cause longer periods of soil saturation (especially in the fall and spring) and could potentially increase the frequency of average annual peak flows. This could have some influence on sediment transport. However, the expectation is that this would not be significant. Defoliation of stands would not result in soil disturbance and subsequent appreciable increases in surface erosion or sedimentation over current levels even if defoliation were to occur on large tracts in areas of greater than 60% host type (B. McCammon, pers. comm., 2000). Thus, defoliation is not predicted to have an impact on stream substrate for bull trout.

Defoliation is predicted to occur in a mosaic pattern of variable intensity. Defoliation effects on rain-on-snow or snowmelt processes are small. This is partly because many of the defoliated trees would not suffer mortality and would grow back their needles in 3-5 years (I. Ragenovich, pers. comm. 2000). If defoliation did result in mortality, tree boles and limbs would remain. Canopy and airflow dynamics that affect snow accumulation and melt are not likely to be different under either the Proposed Action or No Action Alternative. Similarly, potential changes in stream flow, related to transpiration decreases defoliation, would probably not differ between alternatives. In any watershed, stream flow would probably only be affected by defoliation only if the defoliation was equivalent to a clear-cut over more than 10-15% of the watershed (Stednick, 1995, Jones and Grant 1996). Only a small percentage of each watershed is proposed for protection to limit defoliation. Because the amount of proposed spraying in any given watershed is much less than fifteen percent of that watershed, the differences in stream flow between the Proposed Action and no action alternative is not likely detectable.

There is a relatively slow recruitment of dead woody debris for a long period, after defoliation. This slow recruitment of dead wood probably provides a longer-term and more stable supply of dying and dead wood compared to more rapid turnover of snags and logs after a stand-replacement wildfire (Youngblood and Wickman, In Press). Channel morphology, habitat complexity, and localized stream characteristics may be altered by an increase in down woody debris from defoliation of riparian vegetation. It would be impractical to quantitatively predict the impacts as to size, quantity, and configuration of this debris because the exact location of defoliation is not predictable. However, it can be predicted that most of

the potential increase in large woody debris would come from areas of high risk host type that become defoliated. This would usually occur in small to moderate sized patches scattered along the stream. An abundant amount of additional input of large woody debris would be suspected to occur in areas of high risk along streams, and very little to no additional input would be suspected in areas of moderate to low risk.

NO ACTION ALTERNATIVE

ALL FORESTS

Bald Eagle Habitat: All nine National Forests have known or potential bald eagle habitat in their boundaries. If an outbreak of the tussock moth occurred in the project area, defoliation and subsequent mortality could occur in bald eagle habitat.

Known or potential bald eagle communal roosting and some nesting sites could be degraded if an outbreak of the tussock moth occurred in the stands. Eagles usually require multi-storied structured stands with an overstory component. Loss of this canopy closure through defoliation and subsequent mortality could reduce the habitat suitability for the eagles. The Umatilla National Forest has an active bald eagle nest that could be negatively impacted by a tussock moth outbreak. However, some of the known bald eagle nest sites that occur in host type, especially on the Ochoco and Winema National Forests, would probably not be negatively affected by an outbreak. Defoliation in stands used for breeding could benefit habitat. These stands still contain large-diameter pines, but are mostly densely stocked Douglas-fir or white fir. Control of stocking is perhaps the best method to prolong the life and health of currently suitable nesting, roosting, and perch trees. Removal of true firs and other understory species in pine forests can reduce stress and susceptibility of pines to bark beetle infestations (USFWS, 1986).

Some bald eagle habitat could be negatively impacted by a reduction in canopy closure and loss of structure in some stands. However, other bald eagle habitat could be beneficially affected by defoliation and subsequent mortality naturally thinning out the stands and thus prolonging the life and health of currently suitable habitat. *In conclusion, there could be both negative and positive effects on bald eagle habitat under the No Action Alternative.*

COLVILLE NATIONAL FOREST

Bull Trout Habitat: Of the 60 miles of known, suspected, or potential bull trout occupied streams in host type, approximately 43 miles occur mainly in non-host species with low risk of defoliation. Defoliation in these areas is not expected to affect bull trout habitat. The 17 miles of bull trout streams adjacent to moderate/high risk areas are scattered in small patches. Defoliation at these sites is not predicted to be extensive enough to cause a substantial change in the aquatic environment. *This alternative would have no effect on bull trout habitat.*

OKANOGAN NATIONAL FOREST

Anadromous Fish Habitat: None of the streams in host type that are occupied by anadromous fish would be protected under this alternative. However, defoliation is not predicted to degrade anadromous fish habitat in these streams. *The No Action Alternative would have no effect on anadromous fish habitat.*

Bull Trout Habitat: None of the streams occupied by bull trout in host type would be protected. There is an isolated spawning and rearing area for bull trout in a substantial amount of high hazard risk host type on 4 miles of Beaver Creek (Methow River tributary). If a DFTM outbreak occurred along this reach, defoliation could be heavy. If defoliation was severe, the loss of shade could lead to an increase in stream temperature, which could degrade the spawning and rearing habitat. All other stream reaches occupied by bull trout in host type would probably not be negatively impacted by a tussock moth outbreak. *The overall effect of this alternative on bull trout habitat would be negative.*

Spotted Owl Habitat: None of the spotted owl critical habitat units, activity centers, or Late Successional Reserves would be protected from a tussock moth outbreak. Habitat losses would be more likely to occur in high-risk host type. In the critical habitat units, there could be an estimated loss of 1700 acres of nesting, roosting, foraging, and dispersal habitat. For outbreaks in the five 0.7-mile buffer activity centers that have the presence of host type, there could be an effect on current or recently occupied spotted owl habitat. An estimated 552 acres of spotted owl habitat could be lost. If tussock moth defoliated Late Successional Reserves, habitat set aside to provide current or future late-successional habitat for the spotted owl could be affected. An estimated 6,200 acres in LSRs could be affected. There would be no disturbance to spotted owls with implementation of this alternative. *There would be a negative effect of the No Action Alternative on owl habitat.*

WENATCHEE NATIONAL FOREST

Anadromous Fish Habitat: None of the streams in host type that are occupied by anadromous fish would be protected from a tussock moth outbreak. There are approximately 18 miles of spawning and rearing reaches in the Wenatchee River drainage where severe defoliation of the adjacent stands by the tussock moth has the potential to degrade the habitat. These include the following: Mission Creek and its tributary Sand Creek, as well as the upper reaches of Peshastin and its tributary, Transen Creek.

Defoliation could cause a substantial reduction in the amount of shade provided to these reaches, thereby causing an increase in stream temperature in these reaches. All other stream reaches in host type occupied or suspected to be occupied by anadromous fish would probably not be affected by a tussock moth outbreak. *Overall, the No Action Alternative would have a negative effect on anadromous fish.*

Bull Trout Habitat: None of the streams known or suspected to provide habitat for bull trout in host type would be protected. This includes known bull trout spawning and rearing sites on the Mad and South Fork Tieton Rivers. There is approximately 5 miles of moderate-risk host type scattered throughout the riparian area. If a severe outbreak occurred in these sites, defoliation and subsequent mortality could result in a loss of shade, potentially increasing stream temperatures. This could degrade bull trout spawning and rearing habitat. These two bull trout spawning and rearing reaches are the only ones known that occur in environmental conditions (i.e. narrow stream reach with 60-100% host type of moderate risk) in which defoliation and subsequent mortality would have this affect. All other streams occupied by bull trout in host type would probably be unaffected. *Overall, the No Action Alternative would have a negative effect on bull trout habitat.*

Spotted Owl Habitat: None of the spotted owl critical habitat units, activity centers, or Late Successional Reserves would be protected from a tussock moth outbreak. Habitat losses due to defoliation and subsequent mortality would more likely occur in high-risk host type. If an outbreak occurred in the critical habitat units, there could be an estimated loss of 3500 acres of nesting, roosting, foraging habitat, and 1500 acres of dispersal habitat. If outbreaks occurred in the 118 0.7-mile buffer activity centers that have the presence of host type, there could be an effect on current or recently occupied spotted owl habitat. It is estimated that 3,200 acres of spotted owl habitat could be lost. None of the Late-Successional Reserve habitat would be protected. During an outbreak, there could be a loss of habitat in areas formerly set aside to provide current or future late-successional habitat for spotted owls. An estimate of 8,200 acres in LSRs and MLSRs could be lost. There would be no disturbance to spotted owls. *This alternative would have a negative effect on owl habitat.*

UMATILLA NATIONAL FOREST

Anadromous Fish Habitat: None of the streams in host type occupied by anadromous fish would be protected. Anadromous fish populations in the North Fork Asotin Creek, North Fork Umatilla River, and the North Fork Meacham Creek could be negatively affected by a tussock moth outbreak. The North Fork Touchet River, Tucannon River, Lookingglass Creek, Mill Creek (Walla Walla and Pomeroy Ranger Districts), Desolation Creek, Camas Creek, and Pearson Creek also provide anadromous fish habitat that could be negatively affected by tussock moth. Based on the magnitude and extent of moderate/high risk host type in these riparian areas, defoliation and subsequent mortality could result in a loss of shade provided to the streams, thus potentially elevating stream temperatures. This could degrade anadromous fish habitat. In total, approximately 179 miles could be negatively affected.

However, the South Fork Walla Walla River and the Wenaha River sub-watersheds would probably benefit

from a DFTM outbreak. The Wenaha River watershed contains a large population of anadromous fish. Prevention of wildfire and insect infestations may be contributing to a decline in in-stream large woody debris in the drainage. Tree mortality in riparian areas could create a new supply of large woody debris. Since tree mortality is predicted to be patchy at these sites, anadromous fish would still have sufficient high quality/low temperature habitat while spots for future fish production might be created.

If there was an outbreak on the Umatilla, 13,000 acres of high-risk host type in the Snake River chinook salmon critical habitat unit ("CHU") could experience heavy defoliation and subsequent mortality. Depending on the extent and magnitude of the outbreak, there is the potential that a reduction of shade would be great enough to cause an increase in stream temperature. The Snake River critical habitat unit could be degraded.

The overall effect of the No Action Alternative on anadromous fish habitat would be negative.

Bull Trout Habitat: None of the streams occupied by bull trout in host type would be protected from a tussock moth outbreak. The bull trout subpopulations in the North Fork Asotin Creek, North Fork Umatilla River, and the North Fork Meacham Creek have the least likelihood of survival on the forest. The Asotin Creek drainage has a single, small, isolated, non-migratory population of bull trout at high risk of extinction. There are major spawning areas for bull trout in the North Fork Umatilla River drainage, of which most is in the North Fork Umatilla Wilderness. These areas contain abundant host type at moderate/high risk. If a severe outbreak occurred in these sites, defoliation and subsequent mortality could result in a loss of shade and increase in stream temperatures. This could degrade bull trout spawning and rearing habitat at these sites. Most of the anadromous fish streams mentioned above also provide habitat for bull trout. If an outbreak occurred in these sites, defoliation could result in an increase in stream temperatures, potentially degrading bull trout habitat. Approximately 98 miles of bull trout streams could be negatively affected by an outbreak. An outbreak in the South Fork Walla Walla River and the Wenaha River watersheds could benefit bull trout habitat through the creation of additional large woody debris. *There would be an overall negative effect on bull trout habitat from the No Action Alternative.*

WALLOWA-WHITMAN NATIONAL FOREST

Anadromous Fish Habitat: No anadromous fish streams in host type would be protected under this No Action Alternative. Some of these could be negatively impacted by an outbreak of tussock moth. These areas include Catherine Creek and tributaries, Indian Creek and tributaries, Lostine River, Big Sheep Creek and tributaries, Imnaha River and Grouse Creek, Joseph Creek and tributaries, and Granite Creek and tributaries. These streams are in areas of abundant moderate/high-risk host type where a tussock moth outbreak could result in

substantial defoliation and subsequent mortality. Loss of canopy closure could elevate stream temperatures and could degrade fish habitat. In total, approximately 92 miles of anadromous fish riparian zones could be negatively affected. All other streams in host type that are occupied by anadromous fish would probably not be affected.

If an outbreak occurred on the Wallowa-Whitman, 50,000 acres of high risk host type in the Snake River chinook and sockeye salmon critical habitat units could experience heavy defoliation and subsequent mortality. Depending on the extent and magnitude of the outbreak, there is the potential that a reduction of shade would be great enough which would cause an increase in stream temperature. The Snake River critical habitat units could be degraded.

The overall effect of this alternative on anadromous fish habitat would be negative.

Bull Trout Habitat: No bull trout streams in host type would be protected. As a result, some streams could be negatively impacted by an outbreak of tussock moth. This includes parts of Lightning Creek, the upper reaches of Lostine River, Minam River, Little Minam River, and Imnaha River. These areas all have abundant moderate/high risk host type where substantial defoliation could elevate stream temperature and degrade bull trout habitat. In total, approximately 85 miles of bull trout streams could be negatively affected. *The effect of the No Action Alternative on bull trout habitat would be negative.*

MALHEUR NATIONAL FOREST

Anadromous Fish Habitat: Since none of the anadromous fish streams in host type would be protected under the No Action Alternative, several reaches could be negatively impacted if a tussock moth outbreak occurred. All are located in the main stem and middle fork drainages of the John Day River, specifically the upper reaches of the Middle Fork John Day River, the headwaters of Vinegar and Clear Creek, and the headwaters of Beech, Fields, Canyon, Deer, and Reynolds Creeks. They are in areas with abundant moderate/high risk in large, contiguous patches. Substantial defoliation and subsequent mortality could increase stream temperatures. In total, about 31 miles could be negatively impacted by a tussock moth outbreak. *The effect of this alternative on anadromous fish habitat would be negative.*

Bull Trout Habitat: No occupied bull trout streams would be protected, and as a result, some could be negatively impacted. This includes Vinegar Creek on the Long Creek Ranger District, the Reynolds Watershed, the headwaters of the Middle Fork of John Day River, and the Phink and Elk Watersheds, particularly the North Fork Malheur River and tributaries of the Middle Fork Malheur River in the McCoy and Wickiup watersheds. Defoliation of the abundant moderate/high risk host type in large, contiguous patches could increase stream temperatures and could degrade the bull trout habitat. In total, approximately 39 miles of bull trout streams could be negatively affected

during a tussock moth outbreak. *There would be a negative effect on bull trout habitat from implementation of the No Action Alternative.*

OCHOCO NATIONAL FOREST

Anadromous Fish Habitat: None of the streams in host type that are occupied by anadromous fish would be protected from a tussock moth outbreak. The entire Ochoco Forest anadromous population is located in a narrow strip near the northern boundary of the Forest. This is also where most of the host type is concentrated. A severe outbreak could reduce shade in portions of this area, potentially elevating stream temperatures and degrading the fish habitat. In total, approximately 102 miles could be negatively impacted. *The effect of this alternative on anadromous fish habitat would be negative.*

WINEMA NATIONAL FOREST

Bull Trout Habitat: Only one known occupied bull trout stream, Threemile Creek, occurs on the Forest, of which 2 miles is in host type. This area would not be protected in this alternative. There is the potential that this portion could be defoliated by the Douglas-fir tussock moth. However, current stream temperatures are below 50°, well in the standard considered acceptable for bull trout (D. Forbes, pers. comm., 1999), and the host is mostly low/moderate-risk or non-host species. If defoliation and mortality occurred, there would still be live, foliated trees to provide stream shade. Tree mortality could have a beneficial effect by increasing the amount of large woody debris that is currently lacking in the stream (B. Rietman, pers. comm., 1999). *The overall effect of the No Action alternative on bull trout habitat would be positive.*

Spotted Owl Habitat: None of the spotted owl critical habitat units, activity centers, or Late Successional Reserves would be protected from a tussock moth outbreak. Habitat losses would be more likely to occur in high-risk host type. If an outbreak occurred in these critical habitat units, there could be an estimated loss of 5,550 acres of nesting, roosting, foraging habitat, and 1,320 acres of dispersal habitat. If outbreaks occurred in the 56 activity centers that have the presence of host type, there could be an effect on current or recently occupied spotted owl habitat. It is estimated that 900 acres of spotted owl habitat could be lost. None of the Late-Successional Reserve habitat would be protected. During an outbreak, there could be a loss of habitat in areas formerly set aside to provide current or future late-successional habitat for spotted owls. An estimate of 8,200 acres in LSRs and MLSRs could be lost. There would be no disturbance to spotted owls.

The effects of degrading or reducing spotted owl and late-successional habitat due to an outbreak of the tussock moth would not be as severe on the Winema as compared to the Okanogan and Wenatchee. Spotted owl nesting, roosting, foraging habitats, and late-successional stands are more contiguous and less fragmented on the Winema National

Forest than the other two forests. *The overall effect of the No Action Alternative on owl habitat would be negative.*

FREMONT NATIONAL FOREST

Bull Trout Habitat: The No Action Alternative would not protect the headwaters of Demming Creek, the only known bull trout reach in host type on the Forest. Approximately 3 miles of the upper reaches are at mostly a moderate risk for defoliation and mortality. Most of this reach is heavily shaded by true firs and could suffer substantial defoliation if a severe tussock moth outbreak occurred. Bull trout habitat could be degraded in this area. Due to population isolation and the high risk of extirpation for the majority of bull trout subpopulations in the Klamath Basin, degradation of the Demming Creek habitat could have negative consequences to this bull trout subpopulation. *This alternative would have a negative effect on bull trout habitat.*

Effects Determination Summary

Anadromous Fish: No Effect – Okanogan National Forest.
May Affect, Likely to Adversely Affect – Wenatchee, Wallowa-Whitman, Umatilla, Malheur, and Ochoco National Forests.

Bull Trout: No Effect – Colville and Winema National Forests. **May Affect, Likely to Adversely Affect** – Okanogan, Wenatchee, Wallowa-Whitman, Umatilla, Malheur, and Fremont National Forests.

Spotted Owl: May Affect, Likely To Adversely Affect – Okanogan, Wenatchee, Winema National Forests. Defoliation and subsequent mortality from the tussock moth could result in a degradation or removal of spotted owl nesting, roosting, forage, or dispersal habitat in critical habitat units.

Bald Eagle: May Affect, Not Likely To Adversely Affect – Colville, Okanogan, Wenatchee, Wallowa-Whitman, Ochoco, Malheur, Winema, and Fremont National Forests. Some bald eagle habitat would be negatively affected by a reduction in canopy closure and loss of structure in some stands. Other bald eagle habitat could be beneficially affected by defoliation and subsequent mortality naturally. **May Affect, Likely to Adversely Affect** – Umatilla. There could be a loss of bald eagle nesting habitat.

PROPOSED ACTION

ALL FORESTS

Bald Eagle Habitat: Bald eagle nests are usually located in multi-storied stands with old-growth characteristics (USFWS, 1986). Many bald eagle nests in host type occur in stands with this type of structure. Green trees weakened by partial defoliation could die from bark beetles or other infestations. Total tree mortality could reduce old growth quality. The Pacific Bald Eagle Recovery Plan states that timber stands used by eagles should be managed to prevent insect infestations where appropriate (USFWS, 1986). Bark beetles are a threat to eagle habitat in certain areas in the Pacific recovery area.

There is one bald eagle nest in host type, on the Umatilla National Forest, that could become unsuitable for nesting by bald eagles if the nest stand was defoliated and was proposed for protection in this alternative. Although there are other bald eagle nest sites in the project area that could be negatively affected by a DFTM outbreak, they were not proposed for protection because the potential for disturbance to the fledglings with application of the pesticides would be more detrimental than the defoliation and subsequent mortality itself.

In some bald eagle habitat, specifically on the Ochoco and Winema National Forests, defoliation in stands used for breeding could actually benefit the habitat. These stands still contain large-diameter pines but with dense Douglas-fir or white fir. Control of stocking could be the best method to prolong the life and health of these currently suitable nesting, roosting, and perch trees. Removal of true firs and other understory species could reduce stress and susceptibility of the pines to bark beetle infestations (USFWS, 1986).

A negative effect of the proposed treatment on bald eagle habitat is as follows. Proposed treatment areas could perpetuate "over-stocked" stands that could reduce the vigor of potential nest trees.

There would be an avoidance of bald eagle nests during project implementation except for the bald eagle nest on the Umatilla (See Umatilla bald eagle effects below). The treatment period for this project is between mid-June and mid-July. Since this coincides with the nesting period (Jan. – Aug.) of the bald eagle, all project aircraft would stay outside of the following "no disturbance buffers" for the following forests:

- Colville, Wenatchee, Wallowa-Whitman: 1 mile horizontal; 1000' vertical
- Ochoco, Winema¹⁴: ½ mile horizontal; 1000' vertical

Defoliation has the potential to degrade Some bald eagle habitat would be negatively impacted by a reduction in canopy closure and loss of structure in some stands. However, other bald eagle habitat could be beneficially affected by defoliation and subsequent mortality naturally thinning out the stands and thus prolonging the life and health of currently suitable habitat. *In conclusion, there could be both negative and positive effects on bald eagle habitat under the Proposed Action.*

COLVILLE NATIONAL FOREST

Bull Trout Habitat: There are no bull trout reaches proposed for protection. Of the 60 miles of known, suspected, or potential bull trout occupied streams in host type, approximately 43 miles occur mainly in non-host species with low risk of defoliation. Defoliation in these areas is not expected to affect bull trout habitat. The 17 miles of bull trout streams adjacent to moderate/high risk

areas are scattered in small patches. Defoliation at these sites is not predicted to be extensive enough to cause a substantial change in the aquatic environment. *The Proposed Action would have no effect on bull trout habitat.*

OKANOGAN NATIONAL FOREST

Anadromous Fish Habitat: No specific anadromous fish reaches were proposed for protection because there are no streams where defoliation is predicted to degrade habitat. However, approximately 55 miles of streams occupied by anadromous fish would be protected in this alternative because Areas of Concern for other resources overlap anadromous fish streams. The potential protection areas include the upper reaches of the Chewuch River, Twisp River, Gold Creek, Wolf Creek, Goat Creek, Lost River, the upper reaches of the Methow River, and Buttermilk Creek. Protection in these areas would have no effect on anadromous fish habitat. In unprotected areas adjacent to anadromous fish habitat, the effects would be the same as those described in the No Action Alternative. *Overall, there would be no effect of the Proposed Action on anadromous fish habitat.*

Bull Trout Habitat: The only isolated spawning and rearing habitat for bull trout on the Okanogan Forest is located in a 4-mile segment of Beaver Creek, a tributary of the Methow River. This reach falls in a substantial amount of high-risk host type. If severe defoliation occurred, an increase in stream temperature could degrade this important habitat. This reach is being proposed for protection in the Proposed Action. In addition, approximately 52 miles are proposed for protection because Areas of Concern for other resources overlap these anadromous fish streams. The potential protection areas include parts of the Chewuch River, Twisp River, Buttermilk Creek, Methow River, Gold Creek, Wolf Creek, Goat Creek, and Early Winters Creek. Protection of these areas would have no effect on bull trout habitat. In unprotected areas, effects would be the same as those described in the No Action Alternative. *The overall effect of the Proposed Action would be positive.*

Spotted Owl Habitat: Under the Proposed Action, approximately 18,000 acres in 2 of the 3 spotted owl critical habitat units would be protected. In addition, all spotted owl activity centers in host type, outside Wilderness, would be protected to prevent degradation of owl habitat: 0.7 mile radius; 5 centers; 3000 acres, some of which overlap critical habitat unit acreage. Parts of the Twisp River and Upper Methow Late Successional Reserves (16,600 acres) would be protected to prevent loss of late successional stands due to defoliation, mortality, and increased risk of wildfire. Several other LSRs in host type would be protected for other resource concerns. In total, about 49,000 acres of LSR would be protected (this acreage may overlap acreage in the critical habitat units and activity centers described above). Treatment would meet all standards and guidelines in the 1994 *Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents In the Range of*

¹⁴ The buffer nest just south of the Mare's Egg Spring protection area would be slightly less than a ½ mile.

the Northern Spotted Owl and the 1998 Okanogan Assessment of the Northeastern Cascades Late Successional Reserves. The project proposal is consistent with these documents as they relate to treating Late Successional Reserves for control of a tussock moth outbreak. Because aircraft could operate in the ¼ mile buffer of many activity centers and in suitable, unsurveyed habitat between mid-June and mid-July, owls could be disturbed. This disturbance could include noise and prop-wash/down-draft caused by low-flying aircraft. Flight paths could cross directly overhead of an activity center, with additional flights alongside. The frequency and location of these flights in relation to the activity centers would be determined by the distribution and location of the tussock moth outbreak. *The overall effect of the Proposed Action on spotted owl habitat would be positive.*

WENATCHEE NATIONAL FOREST

Anadromous Fish Habitat: There are several spawning and rearing reaches in the Wenatchee River drainage, specifically in Mission Creek, Sand Creek, the upper reaches of Peshastin, and Transen Creek. Approximately 18 miles were identified as spawning and rearing habitat for anadromous fish where severe defoliation could degrade habitat (stream temperature increase). For this reason, these areas were selected for protection in the Proposed Action. Stand and vegetative structure would be maintained. An additional 23 miles of short, scattered stream segments would be protected for other resource concerns (the Naches, Nile, Rattlesnake, Little Rattlesnake, upper reaches of the Entiat, Mad, Wenatchee, and Chiwawa Rivers). Protection of these areas would have no effect on anadromous fish habitat. In unprotected areas adjacent to anadromous fish habitat, effects would be the same as those described in the No Action Alternative. *There would be a positive overall effect of the Proposed Action on anadromous fish habitat.*

Bull Trout Habitat: There are bull trout spawning and rearing sites on the Mad and South Fork Tieton Rivers. Approximately 5 miles have patches of moderate-risk host type scattered throughout their riparian areas. If a severe outbreak occurred in these sites, defoliation and subsequent mortality could result in elevated stream temperatures and degrade bull trout habitat. These two bull trout spawning and rearing reaches are the only ones known that occur in environmental conditions (i.e. narrow stream reach with 60-100% host type of moderate risk) in which defoliation and subsequent mortality would have this affect. About 5 miles are proposed for protection in the Proposed Action. Approximately 19 miles of known, suspected, or potential bull trout habitat would also be protected but for other resource concerns. This includes portions of the Entiat River, Chiwawa River, Wenatchee River, Peshastin Creek, Teanaway River, Naches River, Nile Creek, Tieton River, and Rattlesnake Creek. Protection of these areas would have no effect on bull trout habitat. In unprotected areas, effects would be the same as those described in the No Action Alternative. *The overall*

effect of the Proposed Action on bull trout habitat would be positive.

Spotted Owl Habitat: Under the Proposed Action, 62,000 acres in 10 of the 17 spotted owl critical habitat units would be protected. In addition, all spotted owl activity centers in host type, outside Wilderness, would be protected to prevent degradation of owl habitat: 0.7 mile radius; 112 centers; 32,000 acres, some of which overlap critical habitat unit acreage. All host type in the following Late-Successional Reserves and Managed Late Successional Reserves would be protected to maintain spotted owl nesting, roosting, foraging and dispersal habitat: Upper Nile, Rattlesnake, Swauk, Deadhorse, Chiwawa, Shady Pass, Lucerne, DM-2, 3, 5, 6, 7, 10, 11 and 12. These LSRs and MLSRs have the greatest potential to be negatively impacted by defoliation and subsequent mortality. The Proposed Action would be protecting approximately 75,000 acres in these areas for the purpose of maintaining spotted owl nesting, roosting, foraging, and dispersal habitat. Several other LSRs and MLSRs would be protected to meet other resource objectives. In total, approximately 82,500 acres would be protected (this acreage may overlap acreage in the critical habitat units and activity centers described above).

Treatment would meet all standards and guidelines in the 1994 *Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents In the Range of the Northern Spotted Owl* and the 1997 *Wenatchee Assessment of the Northeastern Cascades Late Successional Reserves*. The project proposal is consistent with these documents as they relate to treating LSRs for control of a tussock moth outbreak.

Because aircraft could operate in the ¼ mile buffer of many activity centers between mid-June and mid-July, owls could be disturbed. This disturbance could include noise and prop-wash/down-draft caused by low-flying aircraft. Flight paths could cross directly overhead of an activity center, with additional flights alongside. However, most juvenile owls in host type on the Cle Elum Ranger District fledge by late May/early June and would be in the rearing stage during project operations. Thus, they would have some ability to move away from the disturbance (J. Richards, pers. comm., 2000). However, other districts on the Wenatchee have activity centers that are proposed for protection that have later fledgling dates. Therefore, there is an increased potential that project aircraft would disturb these young prior to them being mobile. The frequency and location of operational flights in relation to the activity centers would be determined by the distribution and location of the tussock moth outbreak. *The overall effect of the Proposed Action on spotted owl habitat would be positive.*

UMATILLA NATIONAL FOREST

Anadromous Fish Habitat: On the Umatilla, bull trout survival was used as an indicator of risk for other salmonids because they are less dependent on external watershed influences than other salmonids. Since most

bull trout habitat overlaps with anadromous fish habitat, protection of anadromous fish habitat was determined by the condition of the bull trout subpopulations (see bull trout effects below).

Protection could prevent defoliation in riparian areas adjacent to 179 miles of anadromous fish occupied streams. This could prevent any increase in stream temperature that could cause a degradation of habitat for anadromous fish. Stand and vegetative structure would be maintained.

Approximately 4,500 acres of riparian areas adjacent to CHU designated streams would be protected from an outbreak of the tussock moth. Stand and vegetative conditions would be maintained. The remaining 11,000 acres of high-risk host type would remain vulnerable to a tussock moth outbreak. However, these areas are not predicted to be degraded if an outbreak occurs. *The overall effect of the Proposed Action on anadromous fish habitat would be positive.*

Bull Trout Habitat: Three drainages are proposed for protection due to the condition of the bull trout populations. Populations in the North Fork Asotin Creek, North Fork Umatilla River, and the North Fork Meacham Creek have the least likelihood of survival on the Forest. The Asotin Creek drainage, with a single, small, isolated, non-migratory population of bull trout is at high risk of extinction and needs the most protection. The Proposed Action would protect upland and adjacent areas of this drainage. Protection of upland and riparian areas in the North Fork Umatilla River drainage is also desirable because major spawning areas have been documented (most of the protection area is in the North Fork Umatilla Wilderness). The North Fork Touchet River, Tucannon River, Lookingglass Creek, Mill Creek on the Walla Walla and Pomeroy Ranger Districts, and Desolation Creek, Camas Creek, and Pearson Creek on the southern half of the Forest would also be protected to maintain the existing habitat.

The magnitude and extent of moderate/high-risk type in the above riparian areas adjacent to the streams could result in degraded bull trout habitat if an outbreak occurred. If an outbreak occurred in these sites, defoliation and subsequent mortality could result in elevated stream temperatures. The protection of the surrounding uplands in the North Fork Asotin, North Fork Umatilla, and North Fork Meacham Creek drainages is to prevent an increase in the risk of a large stand replacement wildfire. Protection would maintain the existing stand and vegetative structure. Nearly 100 miles of bull trout streams could be protected.

Protection is not proposed in the South Fork Walla Walla River and Wenaha River watersheds, even though riparian habitat adjacent to bull trout streams are present in tussock moth host type. The Wenaha River watershed has a large population of bull trout - the migratory component is intact and migration corridors are present. Some of this watershed is in Wilderness. Prevention of wildfire and

insect infestations may actually be contributing to declines in in-stream large woody debris in the drainage. Some mortality in riparian could benefit bull trout by creating a new supply of large woody debris. Since tree mortality is predicted to be patchy, bull trout would still have sufficient high quality/low temperature habitat while spots for future fish production were created. Effects on unprotected areas would be the same as those described in the No Action Alternative. *The overall effect of the Proposed Action on bull trout habitat would be positive.*

Bald Eagle Habitat: There is one active bald eagle nest on the Forest. Of the 125 acres of core nesting habitat (¼ mile around the nest), 50 are in host type. This area would be protected to maintain this nest site in the Proposed Action. Loss of tree cover from defoliation could negatively affect the habitat. If an outbreak occurred at this site, implementation of this alternative could involve treatment over both the nesting habitat and possibly the nest tree. This could create a disturbance to nesting eagles. However, past observations of the nest have shown that the juvenile eagles would probably have already fledged from the nest (C. Gobar, pers. comm., 1999). Project aircraft could startle birds from the nest, but that is predicted to be the extent of the impact. *The overall effect of the Proposed Action on bald eagle habitat would be positive.*

WALLOWA-WHITMAN NATIONAL FOREST

Anadromous Fish Habitat: Approximately 92 miles anadromous fish streams would be protected in the Proposed Action to prevent defoliation that could degrade habitat. This would include Catherine Creek and tributaries, Indian Creek and tributaries, Lostine River, Big Sheep Creek and tributaries, Imnaha River and Grouse Creek, Joseph Creek and tributaries, Granite Creek and tributaries, plus other small stream segments. The riparian areas adjacent to these streams have abundant moderate/high risk host type in which a tussock moth outbreak could result in substantial defoliation and subsequent mortality. This could result in a loss of canopy closure to the extent that might elevate stream temperature and potentially degrade anadromous fish habitat. In unprotected areas, effects would be the same as those described in the No Action Alternative.

Approximately 20,000 acres of riparian areas adjacent critical habitat unit streams would be protected from an outbreak of the tussock moth. Stand and vegetative conditions would be maintained. The remaining 44,000 acres of high-risk host type would remain vulnerable to a tussock moth outbreak. These areas are not predicted to be degraded if an outbreak occurs. *The overall effect of the Proposed Action on anadromous fish habitat would be positive.*

Bull Trout Habitat: The Proposed Action would protect approximately 85 miles of bull trout streams to prevent defoliation and possible degradation of bull trout habitat. This would include Lightning Creek, upper reaches of Lostine River, Minam River, Little Minam River, Imnaha River and other small stream segments. These streams are

bordered by abundant moderate/high risk host type in which a tussock moth outbreak could result in substantial defoliation and subsequent mortality. Bull trout streams in these areas could lose canopy closure to an extent that might elevate stream temperature and potentially degrade bull trout habitat. In unprotected areas, effects would be the same as those described in the No Action Alternative. *The overall effect of the Proposed Action on bull trout habitat would be positive.*

MALHEUR NATIONAL FOREST

Anadromous Fish Habitat: In this Proposed Action, several anadromous fish stream segments would be protected from tussock moth. These provide spawning and rearing habitat for anadromous fish where severe defoliation could degrade habitat. The reaches are all located in the main stem and middle fork drainages of the John Day River: upper reaches of the Middle Fork John Day River, headwaters of Vinegar and Clear Creek; and headwaters of Beech, Fields, Canyon, Deer, and Reynolds Creeks. All occur adjacent to large patches of moderate/high-risk host type. About 31 miles would be protected; the existing stand and vegetative structure would remain. In unprotected areas, effects would be the same as those described in the No Action Alternative. *The overall effect of the Proposed Action on anadromous fish habitat would be positive.*

Bull Trout Habitat: Approximately 39 miles of bull trout habitat would be protected in this Proposed Action: Vinegar Creek in the Long Creek Ranger District, streams in the Reynolds Watershed, the headwaters of the Middle Fork of John Day River, streams in the Phink and Elk Watersheds (especially the North Fork Malheur River), and tributaries of the Middle Fork Malheur River in the McCoy and Wickiup watersheds. The riparian areas along these streams have large contiguous patches of moderate/high-risk host type. Substantial defoliation and mortality could cause a loss of canopy closure sufficient to increase stream temperatures. Protection would maintain the existing stand and vegetative structure. In unprotected areas, effects would be the same as those described in the No Action Alternative. *The overall effect of the Proposed Action on bull trout habitat would be positive.*



OCHOCO NATIONAL FOREST

Anadromous Fish Habitat: Most of the anadromous fish streams in host type would be protected because the entire anadromous population on the Forest is where most of the DFTM host type is concentrated. A severe outbreak of tussock moth could degrade the habitat. In total, approximately 102 miles of anadromous fish streams would be protected from defoliation. Anadromous streams in the Black Canyon and Mill Creek Wildernesses would not be protected. Natural disturbance would be allowed to take place in these areas. In these unprotected areas, effects would be the same as those described in the No

Action Alternative. *The overall effect of the Proposed Action on anadromous fish habitat would be positive.*

WINEMA NATIONAL FOREST

Bull Trout Habitat: Only one known occupied bull trout stream, Threemile Creek, occurs on the Forest, of which 2 miles is in host type. This area would not be protected in the Proposed Action. Although there is the potential for defoliation, current stream temperatures (< 50°) and the abundance of low/moderate-risk or non-host species would probably not affect bull trout habitat. Stand mortality could be beneficial by increasing the amount of large woody debris (B. Rietman, pers. comm., 1999). *The overall effect of the Proposed Action on bull trout habitat would be positive.*

Spotted Owl Habitat: Under the Proposed Action, neither of the two spotted owl critical habitat units would be protected. However, 2 spotted owl activity centers in host type, outside Wilderness, would be protected: 0.7 mile radius; 1600 acres. There would also be no protection of Late Successional Reserves. Treatment of the activity centers would meet all standards and guidelines in the 1994 Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents In the Range of the Northern Spotted. Because aircraft could operate in the ¼ mile buffer of these two activity centers between mid-June and mid-July, owls could be disturbed. This disturbance could include noise and prop-wash/down-draft caused by low-flying aircraft. Flight paths could cross directly overhead of an activity center, with additional flights alongside. The frequency and location of these flights in relation to the activity centers would be determined by the distribution and location of the tussock moth outbreak. *The overall effect of the Proposed Action on spotted owl habitat would be positive.*

Bald Eagle Habitat: The Winema National Forest designated bald eagle habitat three ways: 1) eagle management area allocations with current or replacement nesting habitat, 2) nest sites with management plans, and 3) winter roost sites. The Proposed Action would incidentally protect just 400 acres of the 11,000 acres of designated habitat. These sites were previously dominated by ponderosa pine but have been invaded by white fir due to the exclusion of fire. Traditionally ponderosa pines have been the preferred roost trees on the Winema. The Proposed Action would prevent defoliation from occurring that potentially could have improved the bald eagle habitat in the area. *If treatment occurred in these 400 acres, there could be a small negative effect on bald eagle habitat under the Proposed Action.*

FREMONT NATIONAL FOREST

Bull Trout Habitat: Demming Creek has an isolated population of bull trout in host type. Approximately 2 miles are at moderate risk and 1 mile is at low risk for defoliation. The Demming Creek fish are one of only seven bull trout populations in the Klamath Basin; they are

considered the strongest and healthiest (C. Speas, pers. comm., 1999). The upper reaches of the creek are predominantly shaded by true firs. The lower reaches pass through non-Forest Service lands but probably also provide habitat for bull trout. Due to the predominance of host type in the upper reaches on National Forest land and isolation of the subpopulation, and the high risk of extirpation to most bull trout populations in the Klamath Basin, this stream would be protected in the Proposed Action. This could prevent an increase in stream temperature and subsequent degradation of habitat. Stand and vegetative structure would be maintained. *The effect of the Proposed Action on bull trout habitat would be positive.*

Effects Determination Summary

Anadromous Fish: No Effect – Okanogan National Forest. **May Affect, Not Likely to Adversely Affect (Beneficial Effect)** – Wenatchee, Wallowa-Whitman, Umatilla, Malheur, and Ochoco National Forests: The Proposed Action, including treatment with TM-BioControl may affect, but is not likely to adversely affect either the anadromous fisheries or its prey base. The protection of anadromous fish habitat from potential degradation of habitat could have a beneficial effect.

Bull Trout: No Effect – Ochoco and Winema National Forests. **May Affect, Not Likely to Adversely Affect (Beneficial Impact)** – Okanogan, Wenatchee, Wallowa-Whitman, Umatilla, Malheur, and Fremont National Forests: The Proposed Action, including treating with TM-BioControl may affect, but is not likely to adversely affect either bull trout or its prey base. The protection of bull trout habitat from potential degradation of habitat could have a beneficial effect.

Spotted Owl: May Affect, Likely To Adversely Affect – Okanogan, Wenatchee, Winema National Forests. The Proposed Action would not remove or degrade any spotted owl habitat defined as nesting, roosting, foraging or dispersal habitat in the estimated home-range, breeding radius, and habitat core surrounding activity centers. The project could potentially benefit habitat for the spotted owl by preventing outbreaks of the tussock moth, thus preventing losses of nesting, roosting, foraging, or dispersal habitat. The project could cause disturbance in a ¼ mile of several activity centers and in un-surveyed suitable habitat via aircraft.

Bald Eagle: No Effect – Colville, Okanogan, Wenatchee, Wallowa-Whitman, Malheur, and Fremont National Forests. Proposed protection would occur outside of a one-mile buffer for all bald eagle nests. **May Affect, Not Likely To Adversely Affect** – Ochoco and Winema National Forest. Proposed protection would occur outside of a ½ mile buffer for all bald eagle nests. **May Affect, Likely to Adversely Affect** – Umatilla National Forest. There is potential for disturbance by protection within 1/4 mile of a bald eagle nest. Preventing degradation of the stand structure surrounding the nest could have a beneficial effect.

EXPANDED PROTECTION ALTERNATIVE

COLVILLE NATIONAL FOREST

Bull Trout Habitat: An additional 51 miles would be protected over that of the Proposed Action. However, there would be no effect on bull trout habitat from the protection of these additional areas. *The overall effect of the Expanded Protection Alternative on bull trout habitat would be the same as the Proposed Action: no effect.*

OKANOGAN NATIONAL FOREST

Anadromous Fish and Bull Trout Habitat: Approximately 23 miles of bull trout occupied streams and 25 miles of anadromous fish occupied streams would be protected over that of the Proposed Action. These areas would have no effect on fish habitat. *The overall effect of the Expanded Protection Alternative would be the same as the Proposed Action: positive.*

Spotted Owl Habitat: This alternative would protect 23,000 acres in 2 of the 3 spotted owl critical habitat units, an increase of 5,000 acres over the Proposed Action. In addition, all spotted owl activity centers in host type, outside Wilderness, would be protected to prevent degradation of owl habitat: 0.7 mile radius; 5 centers; 3000 acres, some of which overlap critical habitat unit acreage. This is the same amount of spotted owl habitat proposed for protection in the Proposed Action. Parts of the Twisp River and Upper Methow Late Successional Reserves (16,600 acres) would be protected to prevent loss of late successional stands due to defoliation, mortality, and increased risk of wildfire. Several other LSRs in host type would be protected for other resource concerns. In addition, the expanded alternative protects from an outbreak of the tussock moth all 60-100% host type in the landscape. In total, about 77,000 acres of LSR would be protected (this acreage may overlap acreage in the critical habitat units and activity centers described above). This is an increase of about 28,000 acres over that of the Proposed Action.

Treatment in these Reserves would meet all standards and guidelines in the 1994 *Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents In the Range of the Northern Spotted Owl* and the 1998 *Okanogan Assessment of the Northeastern Cascades Late Successional Reserves*. The project proposal is consistent with these documents as they relate to treating Late Successional Reserves for control of a tussock moth outbreak.

Because aircraft could operate in the ¼ mile buffer of many activity centers between mid-June and mid-July, owls could be disturbed. The potential for disturbance with implementation of this alternative would be greater than the Proposed Action because protection could occur over more lands considered un-surveyed spotted owl habitat. *However, the overall effect of the Expanded Protection Alternative on spotted owl habitat would be positive.*

WENATCHEE NATIONAL FOREST

Anadromous Fish and Bull Trout Habitat: Approximately 7 miles of bull trout and anadromous fish occupied streams would be protected over that of the Proposed Action. These areas would have no effect on fish habitat. *The overall effect of the Expanded Protection Alternative would be the same as the Proposed Action: positive.*

Spotted Owl Habitat: This alternative would protect 80,000 acres in 10 of the 17 spotted owl critical habitat units on the Wenatchee National Forest. This would be an increase of 18,000 acres over that of the Proposed Action. As with the Proposed Action, all spotted owl activity centers in host type, outside Wilderness, would be protected to prevent degradation of owl habitat: 0.7 mile radius; 112 centers; 32,000 acres, some of which overlap critical habitat unit acreage. Similar to the Proposed Action, all host type in the following Late-Successional Reserves and Managed Late Successional Reserves would be protected to maintain spotted owl nesting, roosting, foraging and dispersal habitat: Upper Nile, Rattlesnake, Swauk, Deadhorse, Chiwawa, Shady Pass, Lucerne, DM-2, 3, 5, 6, 7, 10, 11 and 12. These LSRs and MLSRs have the greatest potential to be adversely impacted by defoliation and subsequent mortality. Several other LSRs and MLSRs would be protected to meet other resource objectives. In addition, the expanded alternative protects from an outbreak of the tussock moth all 60-100% host type. Thus, approximately 96,000 acres would be protected (this acreage may overlap acreage in the critical habitat units and activity centers described above).

Treatment would meet all standards and guidelines in the 1994 *Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents In the Range of the Northern Spotted Owl* and the 1997 *Wenatchee Assessment of the Northeastern Cascades Late Successional Reserves*. The project proposal is consistent with these documents as they relate to treating LSRs for control of a tussock moth outbreak.

Because aircraft could operate in the ¼ mile buffer of many activity centers between mid-June and mid-July, owls could be disturbed. This disturbance could include noise and prop-wash/down-draft caused by low-flying aircraft. Flight paths could cross directly overhead of an activity center, with additional flights alongside. Since most juvenile owls in host type on Wenatchee Forest fledge by late May/early June, would be in the rearing stage during project operations. Thus, they would have some ability to move away from the disturbance (J. Richards, pers. comm., 2000). However, other districts on the Wenatchee have activity centers that are proposed for protection that have later fledgling dates. Therefore, there is an increased potential that project aircraft would disturb these young prior to them being mobile. The frequency and location of operational flights in relation to the activity centers would be determined by the distribution and location of the tussock moth outbreak.

Although this alternative protects more acreage of spotted owl habitat than the Proposed Action, substantial increases in benefits to the owls are not expected. Most high-risk and important habitat is protected in the Proposed Action. *The overall effect of the Expanded Alternative on spotted owl habitat would be positive.*

UMATILLA NATIONAL FOREST

Anadromous Fish and Bull Trout Habitat: Protection areas and effects would be the same as in the Proposed Action.

Approximately 13,500 acres of riparian areas adjacent to critical habitat unit streams would be protected from an outbreak of the tussock moth. Stand and vegetative conditions would be maintained. The remaining 7,000 acres of high risk host type would remain vulnerable to a tussock moth outbreak. However, these areas vulnerable to DFTM are not predicted to be degraded if an outbreak occurred. *The overall effect of the Expanded Protection Alternative on fish habitat would be positive.*

Bald Eagle Habitat: Protection areas and effects would be the same as in the Proposed Action. *The overall effect of the Expanded Protection Alternative on bald eagle habitat would be positive.*

WALLOWA NATIONAL FOREST

Anadromous Fish Habitat: Another 342 miles would be protected over that of the Proposed Action. However, these additional areas would have no effect on anadromous fish habitat.

Approximately 80,000 acres of riparian areas adjacent to critical habitat unit designated streams would be protected from an outbreak of the tussock moth. Stand and vegetative conditions would be maintained. The remaining 16,000 acres of high risk host type would remain vulnerable to a tussock moth outbreak. However, these areas are not predicted to be degraded if an outbreak occurs. *The overall effect of the Expanded Protection Alternative would be the same as the Proposed Action: positive.*

Bull Trout Habitat: Twenty-one miles of streams would be protected in addition to the Proposed Action. These additional areas would have no effect on bull trout habitat. *The overall effect of the Expanded Protection Alternative on bull trout habitat would be the same as the Proposed Action: positive.*

MALHEUR NATIONAL FOREST

Anadromous Fish Habitat: Approximately 81 more miles of stream would be protected over that of the Proposed Action, but with no effect on anadromous fish habitat. *The overall effect of the Expanded Protection Alternative would be the same as the Proposed Action: positive.*

Bull Trout Habitat: This alternative would protect an additional 47 miles of stream over that of the Proposed Action. However, there would be no effect on bull trout habitat. *The overall effect of the Expanded Protection*

Alternative would be the same as the Proposed Action: positive.

OCHOCO NATIONAL FOREST

Anadromous Fish Habitat: Protection areas and effects would be the same as in the Proposed Action. *The overall effect of the Expanded Protection Alternative would be positive.*

WINEMA NATIONAL FOREST

Bull Trout Habitat: Lack of protection areas and effects would be the same as in the Proposed Action. *The overall effect of the Expanded Protection Alternative would be positive.*

Spotted Owl Habitat: This alternative would protect 29,000 acres in both of the spotted owl critical habitat units on the Winema Forest. Protection would be provided to 41 spotted owl activity centers on 2400 acres of host type outside Wilderness. Since all 60-100% DFTM host type would be protected, some of the areas would include Late Successional Reserves (35,000 acres). Treatment would meet all standards and guidelines in the 1994 *Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents In the Range of the Northern Spotted Owl* and the 1998 *South Cascades Late Successional Reserve Assessment*.

The potential for disturbance would be greater than the Proposed Action because protection could occur over more lands considered un-surveyed spotted owl habitat. Although this alternative protects more spotted owl habitat than the Proposed Action, substantial increases in benefits to owls is not expected. Reasons for this are explained in the No Action Alternative. *As with the Proposed Action, overall effect of the Expanded Alternative on spotted owl habitat would be positive.*

Bald Eagle Habitat: The expanded alternative would protect 1,400 acres of the 11,000 acres in designated eagle habitat. This would prevent defoliation that could have improved bald eagle habitat in the area. As a result, *there would be a small negative effect on bald eagle habitat under the Expanded Protection Alternative, more so than in the Proposed Action.*

FREMONT NATIONAL FOREST

Bull Trout Habitat: Protection areas and effects would be the same as in the Proposed Action. *The overall effect of the Expanded Protection Alternative would be positive.*

Effects Determination Summary

Anadromous Fish: **No Effect** – Okanogan National Forest. **May Affect, Not Likely to Adversely Affect (Beneficial Impact)** – Wenatchee, Wallowa-Whitman, Umatilla, Malheur, and Ochoco National Forests (see Proposed Action).

Bull Trout: **No Effect** – Ochoco and Winema National Forests. **May Affect, Not Likely to Adversely Affect (Beneficial Impact)** – Okanogan, Wenatchee, Wallowa-

Whitman, Umatilla, Malheur, and Fremont National Forests (see Proposed Action).

Spotted Owl: **May Affect, Likely to Adversely Affect** – Okanogan, Wenatchee, Winema National Forests (see Proposed Action).

Bald Eagle: **No Effect** – Colville, Okanogan, Wenatchee, Wallowa-Whitman, Malheur, and Fremont National Forests (see Proposed Action). **May Affect, Not Likely to Adversely Affect** – Ochoco and Winema National Forests (see Proposed Action). **May Affect, Likely to Adversely Affect** – Umatilla National Forest (see Proposed Action).

TM-BIOCONTROL ONLY ALTERNATIVE

ALL FORESTS

Anadromous Fish and Bull Trout Habitat: All of the same streams protected in the Proposed Action also would be treated with TM BioControl only and would be protected in this alternative. Therefore, effects for this alternative are the same as those for the Proposed Action for all Forests.

COLVILLE NATIONAL FOREST

Bull Trout Habitat: *No effect.*

OKANOGAN NATIONAL FOREST

Anadromous Fish and Bull Trout Habitat: *Positive effect.*

Spotted Owl Habitat: Treatment area and effects same as Proposed Action. *The overall effect of the TM-BioControl Only Alternative on spotted owl habitat would be positive.*

WENATCHEE NATIONAL FOREST

Anadromous Fish and Bull Trout Habitat: *Positive effect.*

Spotted Owl: Treatment area and effects same as Proposed Action. *The overall effect of the TM-BioControl Only Alternative on spotted owl habitat would be positive.*

UMATILLA NATIONAL FOREST

Anadromous Fish and Bull Trout Habitat: *Same as Proposed Action. Positive effects.*

Bald Eagle Habitat: Protection areas and effects would be the same as in the Proposed Action. *The overall effect of the TM-BioControl Only Alternative on bald eagle habitat would be positive.*

WALLOWA-WHITMAN NATIONAL FOREST

Anadromous Fish and Bull Trout Habitat: *Positive effect.*

MALHEUR NATIONAL FOREST

Anadromous Fish and Bull Trout Habitat: *Positive effect.*

OCHOCO NATIONAL FOREST

Anadromous Fish Habitat: *Positive effect.*

WINEMA NATIONAL FOREST

Bull Trout Habitat: *Positive effect.*

Spotted Owl Habitat: Protection areas and effects would be the same as in the Proposed Action. *The overall effect of this alternative on spotted owl habitat would be positive.*

Bald Eagle Habitat: Protection areas and effects would be the same as in the Proposed Action. *There would be a small negative effect under the TM-BioControl Only Alternative.*

FREMONT NATIONAL FOREST

Bull Trout Habitat: *Positive Effect.*

Effects Determination Summary

Anadromous Fish: No Effect – Okanogan National Forest. **May Affect, Not Likely to Adversely Affect (Beneficial Impact)** – Wenatchee, Wallowa-Whitman, Umatilla, Malheur, and Ochoco National Forests (see Proposed Action).

Bull Trout: No Effect – Ochoco and Winema National Forests. **May Affect, Not Likely to Adversely Affect (Beneficial Impact)** – Okanogan, Wenatchee, Wallowa-Whitman, Umatilla, Malheur, and Fremont National Forests (see Proposed Action).

Spotted Owl: May Affect, Likely to Adversely Affect – Okanogan, Wenatchee, Winema National Forests (see Proposed Action).

Bald Eagle: No Effect – Colville, Okanogan, Wenatchee, Wallowa-Whitman, Malheur, and Fremont National Forests (see Proposed Action). **May Affect, Not Likely to Adversely Affect** – Ochoco and Winema National Forests (see Proposed Action). **May Affect, Likely to Adversely Affect** – Umatilla National Forest (see Proposed Action).

FISH & WILDLIFE: OTHER THREATENED AND ENDANGERED SPECIES

NO ACTION

ALL FORESTS

Lynx Habitat: If there was a DFTM outbreak on any of the eight national Forests with documented or suspected occurrences of lynx, defoliation and subsequent mortality would probably not affect lynx habitat. Generally, outbreaks are predicted for dry-site environments at low elevations, whereas lynx habitat typically occurs at high elevation with lodgepole pine, Englemann spruce, and subalpine fir. The majority of potential defoliation and subsequent mortality caused by a tussock moth outbreak would not occur in lynx habitat. *This alternative would have no effect on lynx habitat.*

COLVILLE NATIONAL FOREST

Caribou Habitat: If a DFTM outbreak occurred in the northeast corner of the Colville National Forest, defoliation and subsequent mortality could cause a slight degradation of caribou habitat. A loss of canopy closure in stands could occur that are providing cover for caribou. A high canopy closure is essential in the winter because it

intercepts snow and makes ground foraging easier.

Canopy closure is also beneficial in the summer because it offers protection from the heat. *Implementation of the No Action Alternative could have a small negative effect on caribou habitat.*

Gray Wolf Habitat: Potential rendezvous or den sites would not be affected by a tussock moth outbreak. Defoliation could reduce canopy closure, possibly causing a reduction in the snow-intercept thermal cover, thermal cover, and lichen habitat favored by ungulate prey species. However, a reduction in canopy closure could also improve understory forage for prey species in outbreak areas. Calving and fawning areas could be reduced in number and quality due to the loss of cover from defoliation and subsequent stand mortality. There would be no change in human/wolf interaction. *In conclusion, the No Action Alternative could have both benefits and consequences to the prey base for the gray wolf.*

Grizzly Bear Habitat: Defoliation and subsequent mortality could improve grizzly bear habitat by creating additional open-structure stands, which provide grizzly bear food sources. There would be no change in human/grizzly bear interaction or disturbance. *The effect of the No Action Alternative on grizzly bear habitat would be positive.*

OKANOGAN NATIONAL FOREST

Gray Wolf Habitat: Potential rendezvous or den sites would not be affected by a tussock moth outbreak. Defoliation could also reduce canopy closure, possibly causing a reduction in the snow-intercept thermal cover, thermal cover, and lichen habitat favored by ungulate prey species. However, a reduction in canopy closure could also improve understory forage for prey species in outbreak areas. Calving and fawning areas could be reduced in number and quality due to the loss of cover from defoliation and subsequent stand mortality. There would be no change in human/wolf interaction. *In conclusion, the No Action Alternative could have both benefits and consequences to the prey base for the gray wolf.*

Grizzly Bear Habitat: Defoliation and subsequent mortality could improve grizzly bear habitat as mentioned for the Colville. *The effect of this alternative on grizzly bear habitat would be positive.*

WENATCHEE NATIONAL FOREST

Gray Wolf Habitat: Potential or known rendezvous or denning sites would not be affected by a tussock moth outbreak. Defoliation could also reduce canopy closure, possibly causing a reduction in the snow-intercept thermal cover, thermal cover, and lichen habitat favored by ungulate prey species. However, a reduction in canopy closure could also improve understory forage for prey species in outbreak areas. Calving and fawning areas could be reduced in number and quality due to the loss of cover from defoliation and subsequent stand mortality. There would be no change in human/wolf interaction. *In conclusion, the No Action Alternative could have both*

benefits and consequences to the prey base for the gray wolf.

Grizzly Bear Habitat: Defoliation and subsequent mortality could improve grizzly bear habitat as mentioned for the Colville. *The effect of this alternative on grizzly bear habitat would be positive.*

Marbled Murrelet: Host type for the Douglas-fir tussock moth does not occur in the areas where incidental sightings of the marbled murrelets have been made on the Wenatchee. *This No Action Alternative would have no effect on marbled murrelet habitat.*

WINEMA NATIONAL FOREST

Shortnose or Lost River Sucker Habitat: No host type for the Douglas-fir tussock moth occurs in or adjacent to sucker habitat. The No Action Alternative would have no effect on sucker habitat.

FREMONT NATIONAL FOREST

Shortnose or Lost River Sucker Habitat: No host type for the Douglas-fir tussock moth occurs in or adjacent to sucker habitat. The No Action Alternative would have no effect on sucker habitat.

Warner Sucker Habitat: No host type occurs in or adjacent to Warner Sucker habitat. Defoliation and subsequent mortality would not have the potential to affect the fish or its habitat. There would be no effect on Warner Sucker habitat from the No Action Alternative.

OTHER FORESTS

There are no other threatened or endangered species on the Umatilla, Wallowa-Whitman, Malheur, or Ochoco Forests in the project area.

Effects Determination Summary

Caribou: **May Effect, Not Likely to Adversely Affect.** There is a potential loss of caribou habitat from DFTM outbreak.

Gray Wolf: **May Effect, Not Likely to Adversely Affect.** There is potential for a reduction in habitat of prey species.

Grizzly Bear: **May Effect, Not Likely to Adversely Affect (Beneficial Impact).** A beneficial effect is possible due to the potential for an increase in food resources for the grizzly bear.

Lynx: **No Effect.**

Shortnose and Lost River Suckers: **No Effect.**

Warner Sucker: **No Effect.**

PROPOSED ACTION

ALL FORESTS

Lynx: The proposed protection areas are generally not in lynx habitat. *Therefore, this alternative is not expected to have any effects on lynx.*

COLVILLE NATIONAL FOREST

Caribou Habitat: Protection is not proposed in caribou habitat on the Colville National Forest. The closest potential protection sites is on the west banks of Sullivan Lake, one-half mile from the known caribou habitat on the Forest. *The Proposed Action would have no effect on caribou habitat.*

Gray Wolf Habitat: Although the entire Forest is considered potential habitat for gray wolf, the areas protected under the Proposed Action do not provide quality habitat due to high road densities and human disturbances. Since wolf rendezvous and den sites would be active during the proposed treatment period, there is the potential, although small, that an unknown or new rendezvous or den site could occur in or adjacent to protection areas.

Protection from defoliation could prevent a loss of canopy closure, which could have led to a reduction in the snow-intercept thermal, thermal cover, and lichen habitat favored by prey ungulates. Protection of these sites could also prevent improvement of understory forage in areas where it is currently deficient. Protection would maintain calving and fawning areas.

There would be no measurable increase in wolf/human interaction and no change in road density. Project operations could create a noise disturbance. If a wolf happened to be present in an area being treated, any potential disturbance is predicted to be short-term and inconsequential. The duration of flyovers would be of short; only one application is proposed; low-flying aircraft traveling at 90 mi/hr and applying pesticide at 50-75 feet above the canopy would make only a few passes for any particular treatment area. In conclusion, the potential for lasting disturbance to any wolf from project operations is unlikely.

In conclusion, prevention of defoliation could have both positive and negative benefits to the prey base for wolves. Any disturbance to the wolf is predicted to be short term and inconsequential.

Grizzly Bear Habitat: The larvae stage of the army cutworm moth is known to be highly susceptible to B.t.k. The moth is in its larvae stage in eastern Washington, most likely in the Palouse region (B. Noble, per. com. 1999). It is thought to enter its adult stage in this area and then migrate to the Cascades in the late spring/early summer. The moth would only be in its adult stage when it is present in the project area. B.t.k. targets the larval stage of Lepidoptera susceptible species. It is unlikely that B.t.k. would affect the adult army cutworm in the project area, and thus is unlikely to impact this potential food supply for the grizzly.

No other bear habitat features (space, isolation, denning, sanitation, safety) would be affected by project implementation. By preventing defoliation in areas proposed for protection, the existing vegetation, stand structure, and food sources would remain unchanged. If treatment occurs in or near an area where a grizzly bear is

present, there is the potential that operational aircraft could disturb bears. However, any disturbance is likely to be short-term and inconsequential for the reasons cited previously for wolves. *There would be no effect of the Proposed Action on grizzly bear habitat.*

OKANOGAN NATIONAL FOREST

Gray Wolf Habitat: Protection is proposed in areas of the Methow Ranger District that have had documented presence of wolves. Some of these areas are relatively isolated with low road densities. These are the places most likely to provide adequate habitat for the species. At these sites, there is the small potential for disturbance to wolves caused by project aircraft.

Protection from defoliation could prevent a loss of canopy closure, which could lead to a reduction in the snow-intercept thermal, thermal cover, and lichen habitat favored by prey ungulates. Protection of these sites could also prevent improvement of understory forage in areas where it is currently deficient. Protection would maintain calving and fawning areas at the treatment sites.

There would be no measurable increase in wolf/human interaction and no change in road density. Project operations could create a noise disturbance. If a wolf happened to be present in an area being treated, any potential disturbance is predicted to be short-term and inconsequential. The duration of flyovers would be of short; only one application is proposed; low-flying aircraft traveling at 90 mi/hr and applying pesticide at 50-75 feet above the canopy would make only a few passes for any particular treatment area.

In conclusion, prevention of defoliation could have both positive and negative benefits to the prey base for wolves. Any disturbance to the wolf is predicted to be short term and inconsequential.

Grizzly Bear Habitat: As mentioned previously for the Colville effects, the Proposed Action is not expected to have any effect on grizzly bear habitat components, including army cutworm moth populations. By preventing defoliation in areas proposed for protection, the existing vegetation, stand structure, and food sources would remain unchanged. Any disturbance from aerial operations is likely to be short-term and inconsequential for the reasons cited previously for wolves. *The Proposed Action would have no effect on grizzly bear habitat.*

WENATCHEE NATIONAL FOREST

Gray Wolf Habitat: Treatment is proposed near areas known to have documented presence of wolves. Some of these are relatively isolated with low road densities, and thus, provide adequate habitat for the species. The two known rendezvous sites on the Wenatchee National Forest are located more than five miles west of any of the proposed protection areas.

Protection from defoliation could prevent a loss of canopy closure, which could lead to a reduction in the snow-intercept thermal, thermal cover, and lichen habitat favored

by prey ungulates. Protection of these sites could also prevent improvement of understory forage in areas where it is currently deficient. Protection would maintain calving and fawning areas at the treatment sites.

There would be no measurable increase in wolf/human interaction and no change in road density. Project operations could create a noise disturbance. If a wolf happened to be present in an area being treated, any potential disturbance is predicted to be short-term and inconsequential. The duration of flyovers would be of short; only one application is proposed; low-flying aircraft traveling at 90 mi/hr and applying pesticide at 75' above the canopy would make only a few passes for any particular treatment area.

In conclusion, prevention of defoliation could have both positive and negative benefits to the prey base for wolves. Any disturbance to the wolf is predicted to be short term and inconsequential.

Grizzly Bear Habitat: As mentioned previously Colville effects, the Proposed Action is not expected to have any effect on grizzly bear habitat components, including army cutworm moth populations. By preventing defoliation in areas proposed for protection, the existing vegetation, stand structure, and food sources would remain unchanged. Any disturbance from aerial operations is likely to be short-term and inconsequential for the reasons cited previously for wolves. *This Proposed Action would have no effect on grizzly bear habitat.*

Marbled Murrelet Habitat: The Proposed Action would not occur in suspected habitat for the murrelet. *There would be no effect on marbled murrelet habitat.*

WINEMA NATIONAL FOREST

Shortnose and Lost River Sucker Habitat: Proposed protection areas occur well to the west of Klamath Basin, the location of the closest known population of Shortnose and Lost River Suckers. *The Proposed Action would have no effect on sucker habitat.*

FREMONT NATIONAL FOREST

Shortnose Sucker and Lost River Sucker: Some proposed protection areas are in the Lost River Basin, about 10-12 miles upstream from Shortnose and Lost River sucker habitat. Protection of these areas would not affect aquatic environments. *The Proposed Action would have no effect on sucker habitat.*

Warner Sucker Habitat: Proposed protection areas occur outside and to the west of Warner Sucker habitat. Located in a different watershed, there is no potential for downstream effects either. *The Proposed Action would have no effect on Warner Sucker habitat.*

OTHER FORESTS

There are no other threatened or endangered species on the Umatilla, Wallowa-Whitman, Malheur, or Ochoco Forests in the project area.

Effects Determination Summary

Caribou: No Effect –Colville National Forest. There is no proposed treatment in caribou habitat on the Colville National Forest. The closest treatment block occurs on the west banks of Sullivan Lake, just outside by about .5 miles of the known caribou habitat on the Forest.

Gray Wolf: May Affect, Not Likely to Adversely Affect. There is a small chance of disturbance to known or unknown rendezvous sites from operation of low-flying aircraft. In the unlikely event that disturbance does occur, it is predicted to be short term and inconsequential due to the duration of the flight.

Grizzly Bear: May Affect, Not Likely to Adversely Affect - Because of the small chance of a disturbance to grizzly bears from operation of low-flying aircraft, there could be a slight negative effect. In the unlikely event that disturbance does occur, it is predicted to be short term and inconsequential due to the duration of the flight.

Lynx: No Effect – Generally, proposed protection blocks are in dry site environments at low elevations. Lynx habitat typically occurs in high elevation stands of lodgepole pine, Englemann spruce, and subalpine fir. The majority of proposed treatment sites would not occur in lynx habitat.

Shortnose and Lost River Suckers: No Effect

Warner Sucker: No Effect

EXPANDED PROTECTION ALTERNATIVE

ALL FORESTS

Lynx: The proposed protection areas are generally not in lynx habitat. *Therefore, this alternative is not expected to have any effects on lynx.*

COLVILLE NATIONAL FOREST

Caribou Habitat: If an outbreak of the tussock moth occurred in the northeast corner of the Colville National Forest, protection could occur in caribou habitat. Protection could prevent loss of canopy closure in stands currently providing cover for caribou. High canopy closure is essential for intercepting snow and making ground foraging easier in the winter and offering protection from heat in the summer. Implementation of this alternative could prevent degradation of these habitat components. Aerial operations could create a noise disturbance. However, if caribou happened to be present in the area being treated, the potential disturbance is predicted to be short-term and inconsequential for the reasons cited previously for wolves. The potential for lasting disturbance to caribou from operation of low-flying aircraft is unlikely. *In conclusion, the overall effect of the Expanded Protection Alternative on caribou habitat is positive.*

Gray Wolf Habitat: Potential protection areas occur throughout the entire Forest, including the Pend Oreille Valley and Selkirk Mountains. Most wolf sightings on the Colville have occurred in these two places. This

alternative could prevent a much greater loss of canopy closure, thermal cover, and lichen habitat than the Proposed Action. Increased protection could also prevent greater improvement of understory forage by maintaining canopy closure. There could also be an increased chance of disturbance to the wolves due to more extended aerial operations. However, any disturbance would still be short-term and inconsequential for the reasons stated in the Proposed Action.

In conclusion, prevention of defoliation could have both positive and negative benefits to the prey base for wolves. Any disturbance to the wolf is predicted to be short term and inconsequential.

OKANOGAN NATIONAL FOREST

Gray Wolf Habitat: Protection is proposed in areas of the Methow Ranger District that have documented presence of wolves. This alternative could also prevent a much greater loss of canopy closure, thermal cover, and lichen habitat than the Proposed Action. Increased protection could also prevent greater improvement of understory forage by maintaining canopy closure. There could also be an increased chance of disturbance to the wolves due to more extended aerial operations. However, any disturbance would still be short-term and inconsequential for the reasons stated in the Proposed Action.

In conclusion, prevention of defoliation could have both positive and negative benefits to the prey base for wolves. Any disturbance to the wolf is predicted to be short term and inconsequential.

Grizzly Bear Habitat: Similar to the Proposed Action, the Expanded Protection alternative is not expected to have any effect on grizzly bear habitat components, including army cutworm moth populations. By preventing defoliation in areas proposed for protection, the existing vegetation, stand structure, and food sources would remain unchanged. Any disturbance from aerial operations is likely to be short-term and inconsequential for the reasons cited previously for wolves. *This Expanded Protection Alternative would have no effect on grizzly bear habitat.*

WENATCHEE NATIONAL FOREST

Gray Wolf Habitat: Protection areas and effects would be the same as in the Proposed Action. *In conclusion, prevention of defoliation could have both positive and negative benefits to the prey base for wolves. Any disturbance to the wolf is predicted to be short term and inconsequential.*

Grizzly Bear Habitat: As mentioned previously, the Proposed Action is not expected to have any effect on grizzly bear habitat components, including army cutworm moth populations. By preventing defoliation in areas proposed for protection, the existing vegetation, stand structure, and food sources would remain unchanged. Any disturbance from aerial operations is likely to be short-term and inconsequential for the reasons cited previously

for wolves. *This Expanded Protection Alternative would have no effect on grizzly bear habitat.*

Marbled Murrelet Habitat: Effects same as Proposed Action. *The Expanded Protection Alternative would have no effect on marbled murrelet habitat.*

WINEMA NATIONAL FOREST

Shortnose and Lost River Sucker Habitat: Proposed protection areas occur well to the west of Klamath Basin, the location of the closest known population of Shortnose and Lost River Suckers. *This alternative would have no effect on sucker habitat.*

FREMONT NATIONAL FOREST

Shortnose Sucker and Lost River Sucker: Some proposed protection areas are in the Lost River Basin, about 10-12 miles upstream from Shortnose and Lost River sucker habitat. Protection of these areas would not affect aquatic environments. *This alternative would have no effect on sucker habitat.*

Warner Sucker Habitat: Proposed protection areas occur outside and to the west of Warner Sucker habitat. Located in a different watershed, there is no potential for downstream effects either. *This alternative would have no effect on Warner Sucker habitat.*

OTHER FORESTS

There are no other threatened or endangered species on the Umatilla, Wallowa-Whitman, Malheur, or Ochoco Forests in the project area.

Effects Determination Summary

Caribou: **May Affect, Not Likely to Adversely Affect** (see Proposed Action).

Gray Wolf: **May Affect, Not Likely to Adversely Affect** (see Proposed Action).

Grizzly Bear: **May Affect, Not Likely to Adversely Affect** (see Proposed Action).

Lynx: **No Effect.**

Shortnose and Lost River Suckers: **No Effect.**

Warner Sucker: **No Effect.**

TM-BIOCONTROL ONLY ALTERNATIVE

ALL FORESTS

Lynx: The proposed protection areas are generally not in lynx habitat. *Therefore, this alternative is not expected to have any effects on lynx.*

COLVILLE NATIONAL FOREST

Caribou: There are no proposed protection areas in caribou habitat under this alternative; *there would be no effect on caribou habitat.*

Gray Wolf Habitat: Protection areas and effects would be the same as in the Proposed Action. *Prevention of defoliation could have both positive and negative benefits*

to the prey base for wolves. Any disturbance to the wolf is predicted to be short term and inconsequential.

OKANOGAN NATIONAL FOREST

Gray Wolf Habitat: Protection areas and effects would be the same as in the Proposed Action. *Prevention of defoliation could have both positive and negative benefits to the prey base for wolves. Any disturbance to the wolf is predicted to be short term and inconsequential.*

Grizzly Bear Habitat: Protection areas and effects would be the same as in the Proposed Action. *There would be no effect from implementation of the TM-BioControl Only Alternative.*

WENATCHEE NATIONAL FOREST

Gray Wolf Habitat: Protection areas and effects would be the same as in the Proposed Action. *Prevention of defoliation could have both positive and negative benefits to the prey base for wolves. Any disturbance to the wolf is predicted to be short term and inconsequential.*

Grizzly Bear Habitat: Protection areas and effects would be the same as in the Proposed Action. *There would be no effect from implementation of the TM-BioControl Only Alternative.*

Marbled Murrelet Habitat: Protection areas and effects would be the same as in the Proposed Action. *There would be no effect from implementation of the TM-BioControl Only Alternative.*

WINEMA NATIONAL FOREST

Shortnose and Lost River Sucker Habitat: Proposed protection areas occur well to the west of Klamath Basin, the location of the closest known population of Shortnose and Lost River Suckers. *This alternative would have no effect on sucker habitat.*

FREMONT NATIONAL FOREST

Shortnose Sucker and Lost River Sucker: Some proposed protection areas are in the Lost River Basin, about 10-12 miles upstream from Shortnose and Lost River sucker habitat. Protection of these areas would not affect aquatic environments. *This alternative would have no effect on sucker habitat.*

Warner Sucker Habitat: Proposed protection areas occur outside and to the west of Warner Sucker habitat. Located in a different watershed, there is no potential for downstream effects either. *This alternative would have no effect on Warner Sucker habitat.*

OTHER FORESTS

There are no other threatened or endangered species on the Umatilla, Wallowa-Whitman, Malheur, or Ochoco Forests in the project area.

Effects Determination Summary

Caribou: **May Affect, Likely to Adversely Affect** (see Proposed Action).

Gray Wolf: May Affect, Not Likely to Adversely Affect
(see Proposed Action.

Grizzly Bear: May Affect, Not Likely to Adversely Affect (see Proposed Action.

Lynx: No Effect.

Shortnose and Lost River Suckers: No Effect.

Warner Sucker: No Effect.

FISH AND WILDLIFE: SENSITIVE SPECIES

In 1995, the Regional Foresters from the Pacific Northwest, Intermountain, and Northern Regions of the Forest Service issued direction that standardized the terminology used to describe effects of actions and projects to sensitive species. The terminology is defined as follows:

- ☐ No Impact ("NI"): A project or activity will have no environmental effect on habitat, individuals, a population, or a species.
- ☐ May Impact Individuals Or Habitat But Will Not Likely Contribute To A Trend Towards Federal Listing or Cause A Loss Of Viability To The Population Or Species ("MIIH"): Activities or actions

that have effects that are immeasurable, minor or are consistent with Conservation Strategies would receive this conclusion. For populations that are small - or vulnerable - each individual may be important for short and long-term viability.

- ☐ Will Impact Individuals Or Habitat With A Consequence That The Action May Contribute To A Trend Towards Federal Listing Or Cause A Loss Of Viability To The Population or Species ("WIFV"): Loss of individuals or habitat can be considered significant when the potential effect may: 1) Contributing to a trend toward Federal listing; 2) Result in a significantly increased risk of loss of viability to a species; or, 3) Result in a significantly increased risk of loss of viability to a significant population (stock).
- ☐ Beneficial Impact ("BI"): Projects or activities that measurably benefit a sensitive species.

Table IV-6, below, provides a summary of the effects to sensitive species of animals. The rationale for the effects determination, identified by superscripts, follows.

Table IV-6: Summary of Effects, Sensitive Fish & Wildlife Species

SPECIES	NO ACTION ALT.	PROPOSED ACTION	EXPANDED PROTECTION ALT.	TM-BIOCONTROL ONLY ALT.
Interior redband trout	NI 3	MIH 1	MIH 1	NI 3
Oregon Lakes tui chub	NI 3	MIH 1	MIH 1	NI 3
Goose Lake Sucker	NI 3	MIH 1	MIH 1	NI 3
Klamath largescale sucker	NI 3	MIH 1	MIH 1	NI 3
Malheur mottled sculpin	NI 3	MIH 1	MIH 1	NI 3
Pit sculpin	NI 3	MIH 1	MIH 1	NI 3
Slender sculpin	NI 3	MIH 1	MIH 1	NI 3
Mid Col. Fall Chinook salmon	MIH	MIH	MIH	MIH
Mid Col. Sp. Chinook salmon	MIH	MIH	MIH	MIH
Larch Mountain Salamander	NI 5	MIH 2	MIH 2	NI 3
Oregon Spotted Frog	NI 5	MIH 2	MIH 2	NI 3
Columbia Spotted Frog	NI 5	MIH 2	MIH 2	NI 3
Northern red-legged frog	NI 5	MIH 2	MIH 2	NI 3
Northwestern pond turtle	NI 5	MIH 2	MIH 2	NI 3
Common loon	NI 1	NI 1	NI 1	NI 1
American white pelican	NI 1	NI 1	NI 1	NI 1
Ferruginous hawk	NI 1	NI 1	NI 1	NI 1
Am. Peregrine Falcon	NI 7	NI 1	NI 7	NI 7
Western sage grouse	NI 1	NI 1	NI 1	NI 1
Greater sandhill crane	NI 1	NI 1	NI 1	NI 1
Long-billed curlew	NI 1	NI 1	NI 1	NI 1
Upland sandpiper	NI 1	NI 1	NI 1	NI 1
Tricolored blackbird	NI 1	NI 1	NI 1	NI 1
Harlequin duck	NI 6	NI 6	NI 6	NI 6
Yellow rail	NI 1	NI 1	NI 1	NI 1
Black rosy finch	NI 1	NI 1	NI 1	NI 1
Preble's shrew	NI	MIH	MIH	MIH
Pacific western big-eared bat	BI	WIFV	WIFV	MIH
Pygmy rabbit	NI 1	NI 1	NI 1	NI 1
California wolverine	NI 4	NI 4	NI 4	NI 4
California bighorn sheep	NI 4	NI 4	NI 4	NI 4
Schuh's homoplectran caddisfly	NI 2	NI 2	NI 2	NI 2
Cascades apatanian caddisfly	NI 2	NI 2	NI 2	NI 2
Blue Mountain cryptochian caddisfly	NI	MIH	MIH	NI
Ft. Dick limnephilus caddisfly	NI 2	NI 2	NI 2	NI 2

Rationale for Determinations of Effects

NI – No Impact

Where there are no impacts to sensitive species, the rationales for such determinations have been categorized. The categories consist of species similarly affected by a particular alternative because of habitat associations, ecological niches, or distribution in the planning area.

NI 1. Species habitat is outside DFTM host type. These species are found in marshlands, alpine environments, sagebrush flats, forest/grassland interfaces, grasslands, or non-montane meadows. These habitats would not be protected under any alternative.

NI 2. Species may occur in or adjacent to forested stands that contain DFTM host types but are NOT in areas proposed for protection.

NI 3. Species may occur in or adjacent to forested stands that contain DFTM host types. They are NOT sensitive to potentially small, immeasurable changes in stream temperature caused by the predicted levels of defoliation or tree mortality. These species are not expected to benefit from the abundance of tussock moths because of a varied diet that includes only minor amounts of Lepidopterans. Use of TM BioControl would reduce only tussock moth populations, keeping total Lepidopteran biomass near baseline conditions. Therefore, there would be no impact.

- NI 4. Species are unaffected by defoliation or tree mortality. B.t.k. or TM BioControl does not affect these species nor are they affected by relative abundance of Lepidoptera as a food source.
- NI 5. Species are unaffected by defoliation or tree mortality; they may feed on Lepidoptera. If so, they would probably not benefit from high populations of Douglas fir tussock moth. Treatment with TM BioControl would reduce only tussock moth populations.
- NI 6. The harlequin duck is known to nest in cavities along and adjacent to streams in forests. It feeds primarily on aquatic animals. It is not affected by B.t.k. or TM BioControl and would not benefit from high populations of Douglas fir tussock moth. There could be very slight but immeasurable benefits from increased tree mortality, but the differences between alternatives is not great enough to warrant different determinations of effects.
- NI 7. Expected levels of defoliation or tree mortality would not affect Peregrine falcons; they do not feed on Lepidoptera but could slightly benefit from increased numbers of insectivorous birds. B.t.k. or TM BioControl does not affect peregrine falcons. Since they are susceptible to disturbance by helicopters, one-mile buffers have been prescribed for eyrie sites. These buffers allow a determination of "No Impact".

MIIH – May Impact Individuals or Habitat, But Will Not Likely Contribute To A Trend Towards Federal Listing or Cause A Loss Of Viability To The Population Or Species

- MIIH 1. Species may occur in or adjacent to forested stands that contain DFTM host types. They are NOT sensitive to potentially small, immeasurable changes in stream temperature caused by the predicted levels of defoliation or tree mortality.
- MIIH 2. B.t.k. could reduce Lepidoptera populations, reducing potential food sources of these species. There is also a limited risk of a negative effect on other aquatic insects (Eidt, 1985; Lacey and others, 1978; Kreutzweiser and others, 1992 & 1993; all cited in USDA, 1995). Because Lepidoptera comprise only a small portion of the diets of these species and protection would not be uniform across the landscape, there should not be impacts to the species that would result in a trend toward Federal listing or a loss of viability.
- MIIH 3. Species may derive a small portion of their food supply from Lepidoptera but feed mostly on other fauna. Because of a varied diet and lack of dependence on Lepidoptera, they are also not likely to benefit from high populations of Douglas

fir tussock moths. Use of TM-BioControl would not adversely impact the species. Use of B.t.k. could reduce local Lepidoptera populations and could adversely impact local populations of the wildlife species. Because they use a varied prey base and protection would not be uniform across the landscape, alternatives that include use of B.t.k. would not cause a loss of viability or trend toward Federal listing.

Other

Mid Columbia Fall and Spring Chinook Salmon: These stocks of salmon are subject to risks from the Douglas fir tussock moth outbreak and proposed protection. Under all alternatives, defoliation and mortality by DFTM could affect streamside shading and consequently, water temperatures. The No Action Alternative could result in the greatest loss of shading. However, based on the expected levels of defoliation in each of the risk categories and the predicted low mortality, overall shade reduction is expected to be small and patchy. Measurable increases in temperature are not expected. This minor, immeasurable effect would not cause a trend toward Federal listing or loss of viability. All other alternatives include unprotected areas in host type that could be defoliated. However, the affect of such defoliation would be less than that of the No Action Alternative; again, there would not be a trend toward Federal listing or a loss of viability.

Use of B.t.k. could result in the loss of significant portions of the Lepidopteran biomass in localized areas. There is some indication that B.t.k. could affect stoneflies or other aquatic insects (Eidt, 1985; et. al., cited in USDA, 1995). These effects could reduce salmon food supplies, adversely impacting fish species. Because of the limited riparian area that would be protected with B.t.k. under the Proposed Action and Expanded Protection Alternatives, potential effects would be small and would not rise to a level that would cause a trend toward Federal listing or a loss of viability.

It is unlikely that these salmon would benefit from large populations of tussock moth because of their varied prey base and lack of evidence that forage is a limiting factor under baseline conditions. Use of TM BioControl would reduce only tussock moth populations, keeping total Lepidopteran biomass near baseline conditions. No impact from a reduction in forage base is expected.

Preble's Shrew: Preble's shrews occur primarily in grasslands and sagebrush habitats. It is unlikely that it occurs in DFTM host type forests. Even if it did, it is unlikely there would be benefits or negative impacts from a tussock moth outbreak. The No Action Alternative would have no impact.

Use of B.t.k. in the Proposed Action could depress populations of Lepidoptera and could have minor impacts on the Preble's shrew food supply. Because the probability of the shrew occurring in protected host type is very small and the acreage to be protected is relatively

small, some individuals may be affected but there would not be a trend toward Federal listing or loss of viability if the Proposed Action were implemented. Protection of additional acreage in the Expanded Protection Alternative would also have little potential impact because of the low probability of Preble's shrew in host type. The effect would remain MIIH.

The use of TM-BioControl only would not affect the shrew's food supply and there is little likelihood the shrew is in host type. The effect would be no impact.

Townsend's Big-Eared Bat: Like many bats, Townsend's big-eared bats feed mostly on flying insects. Lepidoptera are an important and significant component of the prey base. The No Action Alternative could benefit the species, as a Douglas fir tussock moth outbreak could provide an abundant, easily accessible food source. This could lead to greater reproductive success and could contribute to overall viability of the species. The No Action Alternative would have a beneficial impact (BI) on Townsend's big-eared bat.

All other alternatives would have a negative impact on the species. Use of B.t.k. could reduce overall Lepidoptera populations. Because the Townsend's big-eared bat feeds so extensively on Lepidoptera, there could be serious impacts to its prey base in localized areas. Few areas proposed for protection have been adequately surveyed for Townsend's bat maternity roosts. If areas around a roost were treated with B.t.k. and Lepidoptera populations were significantly reduced, there could be adverse impacts to reproduction and adult bats. Because populations of Townsend's bat are already low, further reductions would likely contribute to a need to list the bat under the Endangered Species Act or cause a loss of viability. The effect of the Proposed Action and Expanded Protection Alternative would be WIFV.

Use of TM-BioControl only would have the least negative affect because of the small number of acres protected and because the impact is limited only to tussock moths. Other Lepidoptera populations would remain near baseline levels. Some individual bats may be affected but there would not be a trend toward Federal listing or loss of viability ("MIIH").

Blue Mountain Cryptochian Caddisfly: There is some indication that B.t.k. may kill stoneflies or other aquatic insects (Eidt, 1985; et. al., cited in USDA, 1995). It is prudent to assume that there could be mortality associated with using B.t.k. However, it also appears that the effects are slight and short duration; they should not cause

significant adverse impacts. The overall effect of the Proposed Action and Expanded Protection Alternative would be MIIH.

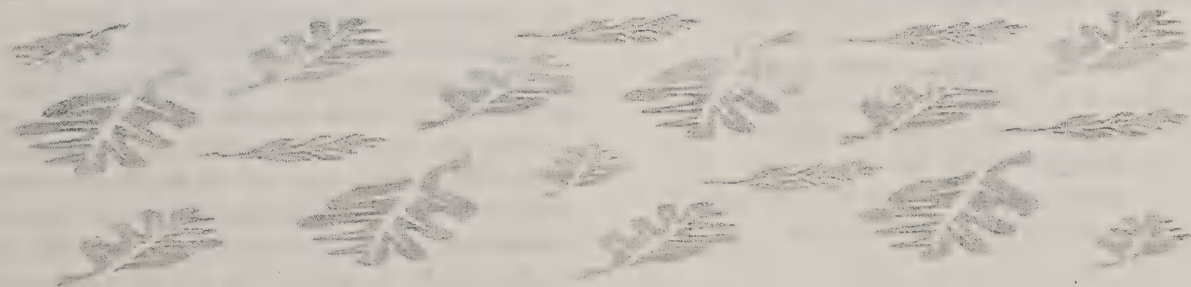
The No Action Alternative would not cause significant increases in water temperature due to defoliation or tree mortality. Caddisflies are not thought to be ultra sensitive to small immeasurable changes in water temperature nor significantly affected by an abundance of tussock moths. TM BioControl has been shown to have no effect on aquatic insects. Thus, the No Action and TM BioControl Only Alternatives would not cause an impact (NI) to the caddisfly.

FISH AND WILDLIFE: "SURVEY AND MANAGE" SPECIES

Aerial treatment of tussock moth is not a ground-disturbing activity. However, to insure protection of the included species, an assessment of the effects on Survey and Manage Species was made for each alternative.

Mollusks: The No Action Alternative would probably have minimal effects on mollusks. Effects of defoliation and tree mortality, while largely unknown, are part of a natural cycle that should not have significant detrimental effects on mollusks. For all other alternatives, the EPA reported in 1998 that there were no effects from B.t.k. on oysters and mussels. Based on these results and the lack of effects to most other species, it is likely that B.t.k. will have no effect on Survey and Manage mollusks during this project. Studies (EPA, 1996) of the effects of TM-BioControl on non-target organisms found there were no effects to species other than tussock moths.

Larch Mountain Salamander: The No-Action alternative would probably not impact Larch Mountain salamanders because although they may eat tussock moths, their generalist feeding habits make them unlikely to benefit from an eruption of tussock moths. For alternatives using B.t.k., there could be a significant reduction of Lepidoptera populations in localized areas. Because Larch Mountain salamanders have a varied diet, it does not depend on Lepidoptera - any reduction of this potential food source would not significantly reduce the salamander population. The Proposed Action and Expanded Protection Alternative would probably affect some individuals but is not expected to cause a trend toward Federal listing or loss of viability. Use of TM-BioControl only would not significantly suppress the overall Lepidoptera population and therefore, would not affect Larch Mountain salamanders.



FISH AND WILDLIFE: OTHER SPECIES

NO ACTION ALTERNATIVE

ALL FORESTS

Barred Owl and Goshawk Habitat: Some barred owls and goshawks could be displaced by defoliation-induced mortality if the outbreak occurred in habitat occupied by these birds. This would probably amount to 1-2% of goshawk and barred owl territories in mixed conifer habitat in the Region. Some Forests could experience local impacts to these populations (less than 5 pairs). *Overall, the No Action Alternative would have a negative effect on barred owl and goshawk habitat.*

Flammulated Owl Habitat: These moth-eating birds could benefit from a tussock moth outbreak (McCallum, 1994). In addition to an increased food supply, flammulated owls could benefit from the creation of additional snags where nest trees are currently limited, if they were in small, scattered patches and if the snags were of sufficient size to provide nesting cavities. Where large blocks of mortality (>200 acres) occurred, flammulated owl habitat could be reduced. These old-growth birds prefer ponderosa pine and/or Douglas fir stands and avoid young-forest conditions (McCallum, 1994; Reynolds and Linkhart, 1987; 1992). Under this alternative, an overall reduction of 1% of the flammulated owl habitat is possible, with potentially larger impacts on a specific watershed or Forest. *Overall, the No Action Alternative would have both negative and positive effects on flammulated owl habitat.*

Mustelid Habitat: Martens and fishers could benefit from no action/protection; both are highly associated with the presence of snags. Scattered tree mortality could improve this habitat in all but the largest blocks. The population of flying squirrels (a major prey of martens) would probably also increase since they are snag dependent. A small, local increase in martens and fishers could occur because of this alternative. *The No Action Alternative would have a positive effect on mustelid habitat.*

Songbird Habitat: Several songbird species could benefit from increased food for 2-3 years under the No Action Alternative. These include ruby-crowned kinglet, Swainson's thrush, western wood pewee, Western tanager, chipping sparrow, and Hammond's flycatcher; more than 20 species of migrant and resident birds eat tussock moths (Torgersen and others, 1984). Several of these species have shown recent declines, particularly those that glean insects from foliage. During an outbreak, it is expected that some bird species would benefit from the increased food supply. That could improve reproductive success or enhance survival. However, after an outbreak, habitat conversion could result in as much as a 15% decline in songbird species associated with mature, dry, mixed conifer forest. For songbird species that rely on open conditions and/or earlier seral stages, there could be long-term benefits. *The overall effect of the No Action*

Alternative on songbird habitat would be both positive and negative.

Woodpecker Habitat: The No Action Alternative could improve woodpeckers habitat. Tree mortality from defoliation could provide additional nesting and feeding sites for primary cavity dwelling species. Habitat could also improve for approximately 40 species of secondary cavity nesters that occur in this habitat (Thomas and others, 1979). In addition, the tussock moths and resultant bark beetles and woodborers would probably become woodpecker food. Scattered mortality of up to 15% of the dense, dry mixed conifer forest with a few large (up to 1000 acres) patches would benefit woodpeckers in these habitats. On any Forest, there could be a short-term population increase of as much as 10% for some species. *The overall effect of the No Action Alternative on woodpecker habitat would be positive.*

PROPOSED ACTION

ALL FORESTS

Barred Owl and Goshawk Habitat: Much of the barred owl and goshawk habitat would remain unprotected in the Proposed Action. Potential effects would be similar to those discussed in the No Action Alternative. In addition, birds could be disturbed by operational aircraft. *Overall, the Proposed Action would have a negative effect on barred owl and goshawk habitat.*

Flammulated Owl Habitat: Potential habitat losses described in the No Action Alternative would diminish from implementation of the Proposed Action. Large blocks of unprotected habitat could experience mortality and habitat loss, especially on the Wallowa-Whitman and Umatilla Forests. Snag increases could benefit flammulated owls where mortality is scattered. The use of B.t.k. could affect the moth food supply for about one year. Small, localized reductions in productivity and population density are possible. *The overall effect of the Proposed Action on flammulated owl habitat would be negative.*

Mustelid Habitat: Protection of forested stands could result in the creation of fewer snags for martens and fishers. However, most of their habitat would not be protected. These species would not be affected by changes in moth populations or aerial operations. *There would be a positive effect of the Proposed Action on mustelid habitat.*

Songbird Habitat: Songbirds could benefit from a DFTM outbreak, but mostly in unprotected areas. The availability of extra food supplies could help some species achieve higher reproductive success or enhance survival (Torgerson, pers. comm., 2000). Since the use of B.t.k. could reduce moth and butterfly populations, this alternative could have a negative effect on birds that eat these insects. The effect would be limited because proposed protection acres are not expected to be extensive and population rebound is expected to occur the following year (Miller, 1990b). In addition, up to 630,000 acres of habitat valuable for species that rely on mixed conifer

would be protected. The potential for habitat conversion and habitat displacement would be lessened. Potential effects from aerial operations are unknown. *The overall effect of the Proposed Action on songbird habitat is both positive and negative.*

Woodpecker Habitat: The Proposed Action would still allow creation of new woodpecker habitat. Extra food would be available in unprotected areas, resulting in a potential 8% increase in the population of some species. Use of B.t.k. would probably not have a measurable effect on woodpeckers because Lepidoptera are not a major part of their diet. Aerial operations would not affect woodpeckers. *The overall effect of the Proposed Action on woodpecker habitat would be positive.*

EXPANDED PROTECTION ALTERNATIVE

ALL FORESTS

Barred Owl and Goshawk Habitat: This alternative could protect barred owl and goshawk habitat in host type. Defoliation-related habitat losses and subsequent displacement could be substantially reduced. Aerial operations could impact young owls or hawks that are ready to fledge but the potential for lasting disturbance to any owl or goshawk from project operations is unlikely. *The overall effect of the Expanded Protection Alternative on barred owl and goshawk habitat would be positive.*

Flammulated Owl Habitat: Use of B.t.k. on a large number of acres could have a substantial negative affect on flammulated owls. A decrease in Lepidoptera could significantly affect flammulated owl food supplies (McCallum, 1994). Prey availability is essential for thermoregulation and survival on cold nights (Ligon, 1968; Webb, 1982). This important food source could be removed for at least one year in a large area. *The effect of the Expanded Protection Alternative on flammulated owl habitat would be negative.*

Mustelid Habitat: Protection of additional forested stands could result in the creation of few snags for martens and fishers. Neither martens nor fishers would be affected by changes in moth populations or aerial operations. *The overall effect of the Expanded Protection Alternative on mustelid habitat would be negative.*

Songbird Habitat: With protection of most host type, habitat conversions would be minimal. This could provide long-term stability for species that rely on dense, old, dry mixed conifer. Songbird species that rely on disturbance to provide younger seral stages would not benefit from this alternative. Use of B.t.k. could cause a loss of food for some foliage gleaning species, particularly the chipping sparrow, ruby-crowned kinglet, yellow-rumped warbler, and Townsend's warbler. These factors could reduce some songbird productivity and survivorship for 2-3 years. Species that prefer open habitats could also be negatively affected since some of their food could be lost and little habitat would be improved for them. *The overall effect of the Expanded Protection Alternative on songbird habitat is negative.*

Woodpecker Habitat: Protection of additional host type would allow much of the existing condition to continue. Unprotected areas could provide extra food and new woodpecker habitat might be created. Use of B.t.k. would probably not have a measurable effect on woodpeckers because Lepidoptera are not a major part of their diet. Aerial operations would not affect woodpeckers. *The overall effect of the Expanded Protection Alternative on woodpecker habitat would be positive.*

TM-BIOCONTROL ONLY ALTERNATIVE

ALL FORESTS

Barred Owl and Goshawk Habitat: Much of the barred owl and goshawk habitat would remain unprotected in this alternative. Potential effects would be similar to those discussed in the No Action Alternative. In addition, operational aircraft could disturb birds. *Overall, the TM-BioControl Only Alternative would have a negative effect on barred owl and goshawk habitat.*

Flammulated Owl Habitat: Much of the flammulated owl habitat would remain unprotected in this alternative. Potential effects would be similar to those discussed in the No Action Alternative. Operational aircraft could disturb birds. *The overall effect of the TM-BioControl Only Alternative on flammulated owl habitat would be both positive and negative.*

Mustelid Habitat: Protection of forested stands could result in the creation of fewer snags for martens and fishers. However, most of their habitat would not be protected. These species would not be affected by changes in moth populations or aerial operations. *There would be a positive effect this alternative on mustelid habitat.*

Songbird Habitat: Use of TM-BioControl only would significantly limit adverse affects on moth-eating birds. The effect of this alternative on unprotected areas would be similar to the No Action Alternative. Some species dependent on mixed conifer Forest could be displaced. Up to 300,000 acres of mixed conifer habitat could be protected, benefiting species dependant on those areas. Songbird response to aircraft is unknown. *The overall effect of the TM-BioControl Only Alternative would be positive.*

Woodpecker Habitat: Most of the woodpecker habitat in host type would not be protected from a DFTM outbreak in this alternative. The effect in unprotected areas would be similar to that described in the No Action Alternative. The effect in protected areas would be similar to the Proposed Action. *The overall effect of the TM-BioControl Only Alternative would be positive.*

LEPIDOPTERA: DOUGLAS-FIR TUSSOCK MOTH

Outbreaks of the Douglas-fir tussock moth occur periodically. Many people living in eastern Oregon remember the tussock moth outbreak of the early 1970s. Others relate concerns with the Douglas-fir tussock moth in the context of their experience with the western spruce budworm *Choristoneura occidentalis* Freeman, another major forest defoliator. It is important to understand the differences in biology and life histories of these two insects in order to address these concerns.

Frequent questions that arise when talking about potential spray projects include:

- What is the effectiveness of the proposed treatment in achieving objectives?
- Will insect populations rebound after treatment?
- What are the effects of treatment on natural predators and parasites?
- Will the treatment contribute to long-term resistance of the insect to the insecticide?

In order to address these questions, a review of information on past outbreaks and treatments, insect biology, and natural control factors was conducted. A summary is presented here; for more information, see Appendix B.

Douglas-fir tussock moth outbreaks occur periodically, approximately every 7-11 years (Mason and Luck, 1978; Swetnam, et. al., 1995; Mason, et. al., 1997). They usually last 3-4 years and then collapse. The collapse is dramatic, and insects are very rare and difficult to find during non-outbreak periods. The Douglas-fir tussock moth belongs to a category of "fast-cycling" insects. They differ from "sustained cycle" insects, such as the western spruce budworm (Shepherd, 1994). This difference determines the appropriateness and success of a proposed treatment. Characteristics of a "fast-cycling" insect include explosive populations, severe defoliation and mortality 1-2 years, and dramatic population collapses. A sustained-cycle insect outbreak builds up more slowly, lasting for a longer period. Severe damage appears only after a number of years of defoliation and impact is related more to duration of defoliation, rather than intensity of defoliation, as occurs in the Douglas-fir tussock moth (Shepherd, 1994). The Western spruce budworm feeds only on new growth. After several years, trees take on a defoliated appearance, as older needles are not replaced by newer ones. Young caterpillars feed individually; opportunity for disease to spread in populations is limited. Partial defoliation over a short period is not as detrimental, and may be somewhat beneficial. Outbreaks are thought to decline from lack of quality food and possibly weather related occurrence. Natural parasites and population increases are able to develop over time, in relation to budworm population increases.

By contrast, hungry Douglas-fir tussock moth larvae can completely defoliate a tree in months. This heavy

defoliation in a short period often causes tree death or makes trees susceptible to secondary mortality. High numbers of individuals feeding together allows tussock moth diseases to spread quickly through populations. As a result, insect populations collapse from starvation and disease. Natural parasites and predators do not play a significant role in population collapse; but are largely responsible for maintaining endemic levels.

The Douglas-fir tussock moth virus is one of the most virulent viruses known (cited in Hughes, 1978), and its role in the collapse of DFTM outbreak populations is well documented. As early as a 1929 outbreak in Idaho, Blach (1932) noticed the ground covered with living and dead caterpillars, many of which had died from starvation, or were apparently diseased. The virus has been reported in association with almost every outbreak since. The virus persists in the soil at very low levels between DFTM outbreaks. Even after over 40 years, soil samples from sheltered locations still contained enough active virus to infect tussock moth larvae. This suggests that the virus may be a natural component of the forest ecosystem for a long time, but is then reintroduced into the forest canopy during a subsequent outbreak. Tussock moth outbreaks have been controlled by the virus in areas where there has been no previously recorded outbreak; whether the virus is somehow transported there, or is residual from an outbreak from years before recording began, or is somehow maintained in the very low DFTM populations indigenous to that area, or a combination of these factors, is less sure.

Virus produced by different age classes varies. The virus produced in the early larval instars remains on the needles where other larvae are likely to encounter the virus. A larger amount of the virus is produced in older larvae and is subsequently incorporated into the duff when they die (Thompson and Scott, 1979). As older larvae die from virus infection, they hang head down, with their legs still attached to the foliage (see photo, right). After death, they fall to a lower branch or the forest floor. They usually rupture, and their liquefied body contents splatter into the organic litter on the forest floor or onto an adjacent branch (Thompson, 1978).

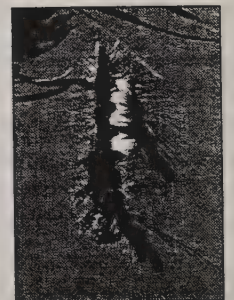


Figure IV-2:
Dead larvae

Two distinct nucleopolyhedrosis viruses ("NPVs") affect DFTM and a few other members of the *Orgyia* genus. One is a single rod virus and the other is a bundled rod virus. Both are highly infectious. The bundled rod virus appears to be slightly more infectious and was the one selected for development as TM BioControl (Hughes, 1978). The viruses are infective to all instars. Pupae frequently die, presumably because they were infected late in the larval life. The virus does not seem to affect adults. Complete resistance of tussock moth has not been found, either in extensive laboratory rearing or in field populations.

Undoubtedly the virus is the most important natural cause of the frequently observed, dramatic decline of Douglas-fir tussock moth populations that characteristically terminates a major outbreak. If the virus were not present in such situations, it is likely that other control factors would take over, although the response would be slower and they would not exert their influence as quickly as the virus. The virus does not appear to be a significant factor in endemic populations or sporadic flare-ups. Other factors, usually a complex of parasites, apparently act significantly on populations during these situations (Wickman, et. al., 1973; Mason, et. al., 1983). A solitary egg parasite, *Telenomus californicus*, is the most dominant and extremely efficient parasite; even when hosts are sparse over 90% of the egg masses may be destroyed. A Diptera parasite, *Agria housei*, is a significant parasite of cocoons, sometimes causing 64-96% cocoon mortality (Torgersen, 1981). There are about 88 species of parasites attacks various life stages of Douglas-fir tussock moth (eggs, larvae and pupae).

A variety of arthropods and insects, such as spiders and ants also cause varying amounts of predation on tussock moth life stages. Insectivorous birds are a major source of mortality at low host densities. This complex of predators and parasites undoubtedly maintains the populations at low levels during non-outbreak years, and is what continues to keep the populations down once an intervening factor such as starvation, virus, or treatment has brought about collapse of an outbreak.

Douglas-fir tussock moth suppression projects have been conducted periodically throughout Idaho, Oregon, Washington, California, and British Columbia. From 1947 until 1974, DDT was the primary insecticide used. In almost all cases, treatment was applied during the decline phase of the outbreak cycle. It is doubtful that any benefit was gained from these treatments because most defoliation and tree mortality occurs during the first years of the outbreak (Wickman, 1978). If foliage protection is an objective for treatment, it must take place prior to significant defoliation.

Both B.t.k. and TM-BioControl have been tested experimentally and used operationally for a number of decades. As early as the 1960's projects using the virus were conducted in Nevada. Numerous additional studies were later conducted in Idaho, Oregon, British Columbia, and California (Stelzer and Neisess, 1978a; Tunnoek, et. al., 1985). It was used operationally against outbreaks in New Mexico in 1978 and 1979. B.t.k. was field tested on various occasions in the early 1970's along with the NPV (Stelzer and Neisess, 1978b). Additionally, it was used operationally in 1989 on 84,000 acres on the Plumas NF. In 1991, 116,000 acres were treated with B.t.k. on the Wallowa-Whitman NF (Hofacker, et. al., 1992).

Between 1983 and 1993, evaluation and suppression projects using B.t.k. were conducted for western spruce budworm suppression throughout Oregon and Washington, primarily east of the Cascades. Since Douglas-fir tussock moth and western spruce budworm both use the same host

species, Douglas-fir and true fir, it is very possible that many of the areas being considered for protection from Douglas-fir tussock moth have been treated at least once, and in some cases twice with B.t.k. in the past 15 years. Although the target insect in these projects was western spruce budworm, most certainly, any Douglas-fir tussock moth in the project areas was also exposed to the B.t.k. applications.

EFFECTIVENESS OF TREATMENT

It is not the intent of the proposed treatment to attempt to control the tussock moth throughout the entire outbreak area. The primary project objective is to provide foliage protection and prevent tree mortality in specific Areas of Concern. Because tussock moth populations build up rapidly, cause significant defoliation in a short period of time, and then quickly collapse, the window for achieving this desired protection is very narrow, and the need to provide foliage protection is limited to one or two years. To prevent damage, populations need to be detected and controlled before tree defoliation occurs.

The insecticides are both biological. B.t.k. causes larvae to cease feeding in a day or two of ingestion. Larvae may continue to feed for slightly longer after ingesting the NPV, and the contagion effect of the virus spreading through the population may take several weeks. As a result, about 15 – 25% defoliation can be expected the year of treatment. In studies testing treatment on very young larvae in British Columbia, there was better tree recovery and significantly less tree mortality in treated versus untreated areas.

Both insecticides appear equally effective in bringing the populations down for the year or two prior to the widespread population collapse. Treatment with either B.t.k. or TM-BioControl prior to peak defoliation would achieve the project objective of protecting trees in the Areas of Concern until there was a natural collapse of the population. Some defoliation would still occur in treated areas. However, tree recovery and the prevention of subsequent tree mortality would achieve the short-term objective of maintaining the current condition of those sites during the current outbreak.

RESURGENCE OR REINVASION FOLLOWING TREATMENT

Concern regarding the effectiveness of treatment is based primarily on the possibility that high insect populations would return one or two years following treatment. Experience with western spruce budworm treatment projects show that large scale projects, for the most part, do not provide more than 1-2 years of foliage protection (Sheehan, 1996a).

In the past, most operational DFTM projects were conducted during the decline phase of the outbreak cycle of the DFTM. The virus had already established an epizootic and populations were collapsing naturally. Resurgence of the outbreak would not have occurred regardless of treatment, because natural factors had already come into play. However, examples where treatment did

take place earlier in the outbreak cycle showed that the lowered prevalence of NPV in the treated plots did not result in recovery of the population to outbreak size (Thompson, 1978; Shepherd, et. al., 1984). No resurgence of a tussock moth population after treatment has ever been recorded.

The rapidity at which the natural virus can spread throughout the population prevents opportunity for DFTM populations to rebound. Once populations return to low levels, natural parasites and predators exert a significant influence on the later stages of decline and help to maintain endemic DFTM populations (Mason, et. al., 1983; Torgersen, pers. comm.).

Since the female Douglas-fir tussock moth does not fly, dispersion is limited to movement of early instar larvae by the wind. However, these larvae do not disperse in high enough numbers to create a new outbreak center before the outbreak collapses (Wickman, et. al., 1973). Therefore, insects do not reinvade treated areas from adjacent untreated areas.

EFFECTS ON NATURAL CONTROL, PREDATORS AND PARASITES

Disruptions of non-target organism populations are of concern when evaluating any alternative control method. The parasite and predator complexes of tussock moth are extremely efficient in locating and maintaining the DFTM populations at low levels. Although DFTM populations experience a rapid build-up and then total collapse in a short period, their parasites are unable to respond as quickly. Rather, they are most effective in maintaining low numbers of DFTM for long periods between outbreaks and in the collapse phase. The parasites respond somewhat to the increased host densities, taking advantage of the reduced host numbers brought about by the virus (Torgersen, personal communication). Treatment with TM-BioControl would not affect natural parasites or predators.

Little work has been done on the effects of B.t.k. on the DFTM parasites and predators. Parasites that would be most likely to be affected by an insecticide application would be those that infect the larval stage. Studies of effects of B.t.k. on parasites of western spruce budworm and gypsy moth report either alteration in abundance of parasites (i.e. there increases in some parasites and decreases in others, or there was no significant effect on the overall parasite complex. The primary parasites and predators of the tussock moth are the egg parasite, *Telenomus californicus*, and avian predators. It is unlikely that treatments with either B.t.k. or TM-BioControl would affect these.

As the virus epizootic runs its course, the infected later instar larvae serve as the primary means for returning the NPV back into the soil in the area. Early instar larvae that die from virus infection remain stuck to the foliage, where the NPV can readily infect other larvae. The greatest effect of applied control, whether with the virus or other insecticides, is to reduce the tussock moth populations so

much that the NPV epizootic develops much more slowly or is prevented (Thompson, 1978). This results in reduced amount of virus in the forest ecosystem. Whether this reduction is significant, is not known. Treatments may cause a reduction in the virus in a localized area; but these impacts may not be comparable to those reductions caused by other disturbance factors. Adjacent untreated areas would serve as a reservoir for initiating future virus epizootics, and treatment would not eliminate the virus from the forest system.

LONG-TERM RESISTANCE OF THE INSECT TO INSECTICIDES

TM-BioControl: This insecticide is made of the natural virus of the tussock moth. Complete resistance of tussock moth to the virus has not been found, either in extensive laboratory rearing or in field populations. It has been proposed that resistance to an epizootic in an insect population is not easily established. By the time an epizootic has run its course, the surviving insects have usually completed their metamorphosis, migrated, or died from other causes, and a new, non-immune population has arisen (Steinhaus, cited in Thompson, 1978). Treatment using TM-BioControl would introduce the virus into the insect population 1-2 years earlier than it would naturally occur. Any resistance or natural selection for resistance against this virus would occur in response to the natural virus, regardless of treatment.

B.t.k.: There is a question regarding the potential build up of resistance in a population through repeated exposure to an insecticide. Douglas-fir tussock moth, in some of the proposed protection areas would have been exposed to one, and possibly two previous treatments with B.t.k. in the last 15 years. Resistance is developed by genetic selection against susceptible individuals in a population. Studies, under field and laboratory conditions, have shown that the diamondback moth, and other agricultural insects, such as the Indian-meal moth and tobacco budworm, and other moths can develop significant resistance through repeated exposure to B.t.k. (Tabashnik, et. al., 1990; Tabashnik, et. al., 1991; Tabashnik, 1994). The tests with diamondback moth did show that the resistance was recessive (Tabashnik, et. al., 1992). Variability in resistance of gypsy moth suggested the potential for resistance development through natural selection (Rossiter, et. al., 1990).

It is very unlikely that resistance to B.t.k. would build up in the tussock moth populations. B.t.k. has little direct effect on the natural enemies; development of those individuals that do not receive a lethal dose of B.t.k. is extended, thereby allowing them more exposure to natural parasites and subsequently being removed from the population. Forest insect populations may be exposed to a B.t.k. treatment once every 7 or 8 years, or even longer, on an average. Infrequent applications are not conducive to development of resistance. Genetic mixing with untreated populations during intervening years would result in any expression of resistance remaining in the background. Refuges of untreated areas, or areas treated with TM-

BioControl would allow genetic variability in the populations.

NO ACTION ALTERNATIVE

No treatment would be done under this alternative. Outbreaks would be allowed to continue under natural conditions. Treatment effectiveness, resurgence and reinvasion, and impacts on predators and parasites would not be an issue. The highest amounts of natural virus would return the forest ecosystem to normal levels under this alternative. Development of resistance to the virus, if it did occur, would be natural. There would be no opportunity for developing resistance to B.t.k., and it would continue to increase the amount of time since the last exposure of the insects to this insecticide.

PROPOSED ACTION

This alternative would protect selected Areas of Concern. All other infested areas would remain unprotected. Use of B.t.k. or TM-BioControl would be effective in reducing those populations in the treated areas and providing foliage protection and preventing tree mortality for the duration of the outbreak. Because of the short outbreak cycle and the fact that the female does not fly, there would be no opportunity for reinvasion into the treated area. There would be no impact on predators and parasites. Treatment may result in less virus being returned to the ecosystem in the treated areas, however it would still be present in untreated areas and the overall ecosystem. Resistance to TM-BioControl is not likely, or if it occurs it would be no different than would occur under natural conditions. Resistance to B.t.k. is not likely because of extended periods of time between exposure to B.t.k. and since there would be refuges of untreated insects in adjacent areas, and areas throughout the forests that would allow for genetic mixing.

EXPANDED PROTECTION ALTERNATIVE

In this alternative, the selected Areas of Concern plus additional areas with 60-100% host type would be protected. As with the Proposed Action, treatment with either TM-BioControl or B.t.k. would be effective in reducing populations in treated areas and providing foliage protection and preventing tree mortality for the duration of the outbreak. Because of the short outbreak cycle and the fact that the female does not fly, there would be not opportunity for reinvasion into the treated area. There would be no impact on predators and parasites. The natural virus exists in the soil for decades between outbreaks and most virus is returned to the soil through the larger infected larvae. During treatment with either B.t.k. or TM-BioControl, most larvae that die would be the younger larvae, and less virus would be returned to the ecosystem. More areas and acres would be treated in this alternative, so overall, there would be fewer viruses returned to the soil in the treated areas. Long-term impact of localized reductions in virus in the forest ecosystem is unknown. Untreated areas (20 – 60% host) would allow development and return of virus to the forest floor. It would still be present in the overall ecosystem, but in

lesser amounts than with the Proposed Action. Resistance to TM-BioControl is not likely, or if it occurs it would be no different than would occur under untreated conditions. More acres would be treated with B.t.k., however, resistance to B.t.k. is not likely because of extended periods of time between exposure to B.t.k., and because there would still be refuges of untreated insects that would allow for genetic mixing.

TM-BIOCONTROL ONLY ALTERNATIVE

This alternative would protect selected Areas of Concern with TM-BioControl only. All other infested areas would remain unprotected. It would be effective in reducing those populations in the treated areas and providing foliage protection and preventing tree mortality. Since the outbreak cycle is very short, only one or two years of foliage protection is required. Because of the short outbreak cycle and the fact that the female does not fly, there would be not opportunity for reinvasion into the treated area. There would be no impact on predators and parasites. The natural virus exists in the soil for decades between outbreaks and most virus is returned to the soil through the larger infected larvae. Treatment of younger larvae could result in less virus in the ecosystem. Long-term impact of localized reductions in virus in the forest ecosystem is unknown, however, untreated areas throughout the forests that would allow development and return of virus to the forest floor, it would be present in the overall ecosystem. Resistance to TM-BioControl is not likely, or if it occurs it would be no different than would occur under untreated conditions.

Table IV-7: Summary of Treatment on Douglas-fir Tussock Moth

	NO ACTION ALT.	PROPOSED ACTION	EXP. PROT. ALT.	TM-B ONLY ALT.
Treatment effectiveness	None	High	High	High
Chance of resurgence or reinvasion	None	None	None	None
Impact on predators/parasites	None	None	None	None
Impact on natural virus	None	Unknown	Unknown	Unknown
Resistance to virus	None	None	None	None
Resistance to B.t.k.	None	None	Very Low	None

LEPIDOPTERA: NON-TARGET

The effects of Douglas-fir tussock moth on other Lepidoptera have not been studied. Competition for food probably exists. Defoliation and tree mortality from DFTM could serve to create Forest openings that would allow more shrubs, forbs, and grasses to grow. Since these plants harbor a significant portion of all Lepidopteran species, DFTM openings could improve overall habitat for other moths and butterflies (Hammond and Miller, 1998).



Effects of B.t.k. on other Moths & Butterflies

B.t.k. is a bacterium-based insecticide that has minimal effects on most terrestrial non-target species. For these species, the effect of B.t.k. is indirect, if present at all.

However, B.t.k. does affect many Lepidoptera species – (moths and butterflies). Given its broad range of efficacy, there can be little question that native species would be affected in a protected area. The magnitude of these effects depends on factors such as the number of applications, dosage, weather conditions, and the size of the protection area (Wagner, et al, 1996).

B.t.k. must be ingested to cause mortality; insects must be in the larval (caterpillar) stage and actively feeding on foliage on which the insecticide has been deposited. B.t.k. has been used in research studies and operationally against Douglas-fir tussock moth. In 1989, 84,000 acres were protected on the Lassen and Plumas National Forests in California (USDA, 1990) and in 1991; 116,000 acres were protected on the Wallowa-Whitman National Forest (USDA, 1992). Effects on non-target Lepidoptera were not monitored on these projects. However, a number of projects using B.t.k. to suppress or eradicate other Forest insects (western spruce budworm, gypsy moth, Asian gypsy moth) were monitored to determine effects on non-targeted species. These studies are individually summarized in Appendix E.

Applications of B.t.k. have been demonstrated to cause a significant decrease in the number of larval and adult Lepidoptera the year of protection (Miller, 1990a; Miller, 1990b; Sample, et al, 1993; Peacock, et al, 1994; Sample, et al, 1995; Johnson, et al, 1995; Miller, 1995; Wagner, et

al, 1996; Peacock, et al, 1998; Hall, et al, 1999). Impacts include a significant decrease in the richness and/or abundance during the year of protection. Recovery to pre-protection levels for most species occurred in one to two years following treatment (Miller, 1990a; Miller, 1990b; Rondenhouse and Holmes, 1992; Sample, et al, 1993; Peacock, et al, 1994; Sample, et al, 1995; Miller 1995; Wagner, et al, 1996). Butterfly species appear to be highly sensitive; sensitivity by moth species appears to be greatly variable (Johnson, et al, 1995; Peacock, et al, 1998). Sensitivity also varies with the age of the larvae and whether the susceptible stage of the larvae coincides with the time of exposure to B.t.k.

A significant decrease in larval populations following protection does not mean that all Lepidopteran larvae are eliminated from the site. Since there would be fewer larvae available, animals feeding on these caterpillars either would search longer or would switch to other food sources.

There is less consistency in the reported effects on adult moth populations between projects. Some report a significant decrease in adult moths the year of protection (Miller, 1995; Hall, et al, 1999); others found few differences in adult populations between protected and unprotected areas (Sample and others, 1995; Grimbale, 1995).

Variations in the results of these studies can be somewhat explained by project objectives. Gypsy moth projects, especially eradication projects, involved 2-3 applications of B.t.k. over a period of several weeks. This results in a much longer exposure for non-target Lepidoptera to B.t.k. In addition, because gypsy moth is a diverse feeder, there are more vegetative hosts, resulting in the need to spray more acres. This diverse habitat is also where the highest numbers of non-target Lepidoptera occur. Western spruce budworm projects specifically target conifer hosts. Areas of non-host species were excluded from protection since they did not harbor the target insect. Thus, many of the areas where significant populations of non-target Lepidoptera are found were eliminated from protection.

The biology of DFTM lends itself to a number of protection options and flexibility that may not be available in other Forest insect control projects. The DFTM is a "fast-cycle" insect and the female moth does not fly. This allows protection of discreet, even small areas without concern of spread or re-infestation back into the protected area. Protection areas can be designed to minimize impacts on non-target Lepidoptera.

There are no known threatened and endangered Lepidoptera species in the areas being considered in this analysis. There are no Lepidoptera on the Regional Forester's Sensitive Species List in the analysis areas. The Mardon Skipper (*Polites mardon*) is a candidate for Federal listing and is on the Washington State Threatened, Endangered, and Sensitive Species list. It does not occur in the analysis areas. Sightings have also been recorded in Klamath County Oregon, which contains some Areas of

Concern and expanded host covered in this analysis. If a project is identified for the Winema NF, additional information on exact locations of the colonies would be obtained to determine if they are in a potential protection area. Other candidate species from Washington that have been sighted in the project area include the Juniper Hairstreak (*Callophrys [Mitoura] ryneus*), Silver-bordered Fritillary (*Boloria selene shepadri*), Great Arctic (*Oeneis nevadensis*), and Shephard's Parnassian (*Parnassius clodius shepardii*). Of these, the Great Arctic occurs in a life stage and a habitat likely to be affected by treatment. Oregon does not have any listed or candidate Lepidoptera. The Sierra Nevada Blue (*Agriades podarce*) is listed as rare or local. It has been found in Klamath County in subalpine meadows; it will be an adult at the time of treatment. Most other rare species in the analysis area do not occur in a susceptible life stage or in a potentially protected habitat. The Garita Skipperling (*Oarisma garita*), Yuma Skipper (*Ochlodes yuma*), American Copper (*Lycaena phlaes*), and Peck's Skipper (*Polites peckius*) occur either in a susceptible life stage or in potentially protected habitat. It is likely that most butterflies in larval feeding stage in protection areas would be affected by B.t.k. It is not known if B.t.k. will cause local extirpation of these species. Most are globally secure over the rest of their range. Hall and others (1999) reported that during an Asian gypsy moth eradication project in North Carolina, there was little evidence to suggest that any species were extirpated from the site; several rare species either survived or re-colonized the area.

Finally, there are no Lepidopteran species introduced for noxious weed control in the project area. Officials from the State Department's of Agriculture have indicated that should larval populations of an introduced biological control be affected by this project, they could be easily reintroduced back into an area (LaGasa and Coombs, pers. comm.).

Effects of TM-BioControl on Moths & Butterflies

TM-BioControl is made from a virus specific to tussock moth. The virus is known to infect only Douglas-fir tussock moth, western tussock moth (*Orgyia cana*), rusty tussock moth (*O. antiqua*), and white-marked tussock moth (*O. leucostigma*). The western and rusty tussock moths occur in the same areas considered for protection from Douglas-fir tussock moths (Thompson, 1978). It is anticipated that populations of these other two species would be affected by TM-BioControl if they reside in the protection area. Impact would be limited to mortality the year of proposed protection. In a normal DFTM outbreak, the natural occurrence of the virus would be significantly higher the following year and would infect the other associated tussock moths in that area.

Effects on Lepidoptera in Wilderness:

The application of protection measures in areas outside of or adjacent to Wilderness should have no effect on Lepidoptera in Wilderness. The only effect on moths and

butterflies in Wilderness would probably be due to drift of the agents into Wilderness. However, project operations can be designed to minimize the likelihood of drift. Mitigation measures could include protecting areas immediately adjacent to Wilderness with TM-BioControl only, by leaving unprotected buffers around Wilderness areas, and by timing applications so that air currents would move spray away from Wilderness rather than into it.

A more detailed discussion of the effects on non-target Lepidoptera is in the analysis file, available upon request.

NO ACTION ALTERNATIVE

Under this alternative, there would be no insecticide impacts to non-target Lepidoptera. Competition for food from DFTM could have a short-term effect on other Lepidoptera. This alternative could result in extensive defoliation and subsequent tree mortality over the outbreak area, which could create forest openings where shrubs and grasses would increase habitat for moths and butterflies.

PROPOSED ACTION

This alternative proposes protection with either B.t.k. or TM-BioControl. Some of the non-target Lepidoptera in protection areas would suffer decreases in populations for 1 – 2 years due to the use of B.t.k. Populations of these other species would recover to pre-protection levels in one to two years. To minimize impacts of B.t.k. on non-targets, the Forest Service proposes to use TM-BioControl only in forested areas where these species provide a critical food supply for other wildlife. These areas include streams, spotted owl nest sites, important wildlife habitat areas, and areas which may harbor unusual Lepidopteran species. Where possible, areas that have little or no host type, or meadows, and forest edges would be left unprotected as non-target refuges. These precautions are expected to minimize the potential impact to non-target Lepidoptera at the landscape level. Reductions in non-targets would be limited to the localized protected areas.

Neither B.t.k. nor TM-BioControl would affect Lepidoptera populations in any unprotected areas. Competition for food from DFTM could have a short-term effect on other Lepidoptera. Defoliation could create large Forest openings where shrubs and grasses would provide increased habitat for moths and butterflies.

EXPANDED PROTECTION ALTERNATIVE

Effects on non-target Lepidoptera would similar to the Proposed Action, except that more acres would be protected with B.t.k. This could cause more short-term impacts on non-target Lepidoptera populations. Overall, impacts would be minimized using precautionary options as stated in the Proposed Action.

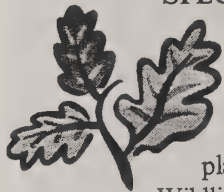
Competition for food from DFTM might have a short-term effect on other Lepidoptera. Fewer acres would be defoliated by tussock moths. Fewer acres that would be converted into forest openings where shrubs and grasses would provide increased habitat for moths and butterflies.

TM-BIOCONTROL ONLY ALTERNATIVE

This alternative proposes protection with TM-BioControl Only. There would be no effects on non-target Lepidoptera other than western and rusty tussock moth.

TM-BioControl would not affect Lepidoptera populations in any unprotected areas. In those areas, competition for food from DFTM could have a short-term effect on other Lepidoptera. Defoliation could create forest openings where shrubs and grasses would provide increased habitat for moths and butterflies.

PLANTS – THREATENED & ENDANGERED SPECIES



The Endangered Species Act requires that actions of federal agencies do not jeopardize threatened or endangered plants or their critical habitats. Proposed plants are those that the US Fish and Wildlife Service has sufficient data to consider for listing but that have not yet been formally listed. For this analysis, the US Fish and Wildlife Service list of threatened and endangered plants in Oregon and Washington was used to determine the status of vascular plant species. Forest botanists were queried to determine whether any of these species were known or suspected to occur in areas that could be affected by project alternatives. The effects analysis included plant habitats in/adjacent to host type, meadows, and riparian areas. Only those plants that could be in potentially affected habitats are discussed in detail.

NO ACTION ALTERNATION

WENATCHEE NATIONAL FOREST

Widespread defoliation could allow an increase in light intensities to reach the forest floor. This could have a beneficial effect on Ute Ladies Tresses (*Spiranthes diluvialis*), Wenatchee Mountain Checkermallow (*Sidalcea oregana*, var. *calva*), or Showy Stickseed (*Hackelia venusta*) if they are stressed by low light conditions. *There would be an overall positive effect of the No Action Alternative on plant habitat.*

UMATILLA NATIONAL FOREST

There are no known threatened or endangered plants on the Forest. A proposed species, Spaulding's silene (*Silene spauldingii*), is mostly pollinated by bees. The species occurs mostly in meadows, possibly on the edges of Douglas-fir types. Defoliation leading to increased light intensity would have no effect. *The No Action Alternative would have no effect on Spaulding's silene habitat.*

WALLOWA-WHITMAN NATIONAL FOREST

Some populations of Spaulding's silene occur along the edge of Douglas-fir host types. Defoliation leading to increased light intensity would have no effect. *The No Action Alternative would have no effect on Spaulding's silene habitat.*

FREMONT NATIONAL FOREST

There are no known threatened, endangered, or proposed plants on the Forest. Possible habitat for Ute ladies tresses exists but the species has not been found. *The No Action Alternative would have no effect on plant habitat.*

ALL OTHER FORESTS

There are no known threatened, endangered, or proposed plants on the Colville, Okanogan, Malheur, Ochoco, or Winema National Forests.

PROPOSED ACTION

WENATCHEE NATIONAL FOREST

Ute Ladies Tresses: This plant has not been found on the Forest. It is possible it could occur in riparian zones but most potential protection areas in this alternative are unlikely habitat for the plant. The known bumblebee pollinator would not be affected by B.t.k. or TM-BioControl. *The Proposed Action would not effect on Ute ladies tresses habitat.*

Wenatchee Mt. Checkermallow: This plant is primarily a wet meadow species. Use of B.t.k. or TM-BioControl would not affect known Hymenoptera pollinators. Use of B.t.k. could affect Lepidopteran pollinators. If the Proposed Action were implemented, treatment would be excluded from a buffer zone around the Camas Lands populations and areas between and around Blewitt Pass. The buffer would include potential plant corridors and surrounding areas. *With the buffer, the Proposed Action would have no effect on Wenatchee Mt. Checkermallow habitat.*

Showy Stickseed: This shade-intolerant species is unlikely to occur in closed canopy forest. Information on plant pollination is limited. If the plant is pollinated by Lepidoptera, use of B.t.k. could have a negative effect on these pollinators. If this alternative were implemented, treatment would be excluded from a buffer zone around known populations. *With this buffer, the Proposed Action would have no effect on Showy Stickseed habitat.*

UMATILLA NATIONAL FOREST

There are no known threatened or endangered plants on the Forest. There would be no effect due to defoliation or on pollinators, for the reasons explained in the No Action Alternative. *The Proposed Action would have no effect on Spaulding's silene habitat.*

WALLOWA-WHITMAN NATIONAL FOREST

Some populations of Spaulding's silene occur on the edge of Douglas-fir host types. A bumblebee, *Bombus fervidus*, is the primary pollinator; it is unlikely there are Lepidopteran pollinators essential for the species. Defoliation in unprotected areas would have no effect. If this alternative were implemented, treatment would be excluded from a buffer zone around known populations. *With this buffer, the Proposed Action would have no effect on Spaulding's silene habitat.*

FREMONT NATIONAL FOREST

There are no known threatened, endangered, or proposed plants on the Forest. Possible habitat for Ute ladies tresses exists but the species has not been found. *The Proposed Action would have no effect on plant habitat.*

ALL OTHER FORESTS

There are no known threatened, endangered, or proposed plants species on the Colville, Okanogan, Malheur, Ochoco, or Winema National Forests.

EXPANDED PROTECTION ALTERNATIVE

WENATCHEE NATIONAL FOREST

The effects of the Expanded Protection Alternative are identical to those of the Proposed Action - no effect on plant habitat with appropriate buffers.

UMATILLA NATIONAL FOREST

The effects of the Expanded Protection Alternative are identical to those of the Proposed Action - no effect on plant habitat.

WALLOWA-WHITMAN NATIONAL FOREST

The effects of the Expanded Protection Alternative are identical to those of the Proposed Action - no effect on plant habitat with appropriate buffers.

FREMONT NATIONAL FOREST

There are no known threatened, endangered, or proposed plants on the Forest. *This alternative would have no effect on plant habitat.*

ALL OTHER FORESTS

There are no known threatened, endangered, or proposed plants species on the Colville, Okanogan, Malheur, Ochoco, or Winema National Forests.

TM-BIOCONTROL ALTERNATIVE

WENATCHEE NATIONAL FOREST

The use of TM-BioControl would have no effect on known or potential Lepidopteran pollinators. *All other effects of this alternative would be the same as the Proposed Action - no effect on plant habitat.*

UMATILLA NATIONAL FOREST

The use of TM-BioControl would have no effect on known or potential Lepidopteran pollinators. *All other effects of this alternative would be the same as the Proposed Action - no effect on plant habitat.*

WALLOWA-WHITMAN NATIONAL FOREST

The use of TM-BioControl would have no effect on known or potential Lepidopteran pollinators. *All other effects of this alternative would be the same as the Proposed Action - no effect on plant habitat.*

FREMONT NATIONAL FOREST

The use of TM-BioControl would have no effect on known or potential Lepidopteran pollinators. *All other effects of this alternative would be the same as the Proposed Action - no effect on plant habitat.*

ALL OTHER FORESTS

There are no known threatened, endangered, or proposed plants species on the Colville, Okanogan, Malheur, Ochoco, or Winema National Forests.

PLANTS – SENSITIVE SPECIES

Sensitive plants are those species that could become eligible for listing as federally threatened or endangered in the future. Sensitive plants are designated by the Pacific Northwest Regional Forester. The National Forest Management Act requires the Forest Service to consider the impact of Proposed Actions on these species and to take actions to insure their viability is not jeopardized. For this analysis, Forest botanists were queried to determine which plants from the April 1999 US Forest Service Region 6 Sensitive Plant Species List might occupy potentially affected habitats. Documented or suspected species in/immediately adjacent to host type, meadows, riparian areas, and other habitats were considered.

NO ACTION ALTERNATIVE

COLVILLE NATIONAL FOREST

There are 35 sensitive species documented or suspected to occur on the Forest. Several *Botrychiums* have been found but most are in cedar types or wetlands. *Cypripedium parviflorum* occurs in Douglas-fir host types and could be negatively impacted by defoliation, due to reduced canopy closure. *The No Action Alternative would have no overall impact on these plant habitats.*

OKANOGAN NATIONAL FOREST

Defoliation is not expected to cause changes in shading or light intensity that would have an impact on sensitive species. *The No Action Alternative would have no impact on plant habitat.*

WENATCHEE NATIONAL FOREST

If large-scale defoliation occurred, there could be a slight beneficial impact on high light intensity species and a slight negative impact on shade tolerant species. *Overall, the No Action Alternative would have no impact on plant habitat.*

UMATILLA NATIONAL FOREST

If defoliation reduced canopy closure, there could be a negative impact on *Cypripedium fasciculatum*. The fleshy roots could also be damaged by fire, resulting from increased forest fuels. *Botrychiums* could benefit from canopy openings. There would be no impact on *Ranunculus populago*, *Bolandra oregana*. *There would probably be no overall impact on plant habitat from the No Action Alternative.*

WALLOWA-WHITMAN NATIONAL FOREST

If defoliation from a DFTM outbreak opened the forest canopy, there could be a beneficial impact on *Botrychiums* from increased light to the understory. *The impact of the No Action Alternative on plant habitat would be positive.*

MALHEUR NATIONAL FOREST

Increased light intensity from tussock moth defoliation could have a beneficial impact on *Luina serpentina* and possibly *Thelypodium ucosomum*. *The overall impact of the No Action Alternative on these plant habitats would be positive.*

OCHOCO NATIONAL FOREST

This alternative could have a beneficial impact on *Botrychiums* because of increased light to the understory. There would be impact to other sensitive plants. *The overall impact of the No Action Alternative on plant habitat would be positive.*

WINEMA NATIONAL FOREST

Defoliation would have no impact on Mount Mazama *Collomia* (*Collomia mazama*) because most populations are located above DFTM host type elevations. There could be a positive impact on blue-leaved penstemon (*Penstemon glaucinus*) if defoliation opened the forest canopy. *There would be no overall impact of the No Action Alternative on these plant habitats.*

FREMONT NATIONAL FOREST

Blue leaved penstemon could benefit from widespread defoliation. Green-tinged paintbrush (*Castilleja chlorotica*) occurs mostly in sagebrush communities and would be unaffected by defoliation. *The overall impact of the No Action Alternative on these plant habitats would be positive.*

PROPOSED ACTION

COLVILLE NATIONAL FOREST

Neither *Cypripedium parviflorum* nor several species of *Botrychium* are pollinated by Lepidoptera. In addition, *Botrychium* are found mostly in cedar types or wetlands and are unlikely to be in proposed protection areas. *As a result, the Proposed Action would have no impact on these plant habitats.*

OKANOGAN NATIONAL FOREST

There are no known sensitive plants in proposed protection areas. Additionally, since most of the Forest sensitive species are wind pollinated or pollinated by non-Lepidoptera insects, it is unlikely that there would be any impact on most species. The mountain dandelion, *Agoseris elata*, is known to have a Lepidoptera pollinator but resides in meadows outside proposed protection areas. There would be no impact from defoliation in unprotected areas. *The Proposed Action would have no overall impact on plant habitats.*

WENATCHEE NATIONAL FOREST

There is little information on pollinators of sensitive plant species on the Wenatchee Forest. Since approximately 25 sensitive plants are estimated to occur in DFTM host type, it is possible that some Lepidoptera pollinate these species and would be susceptible to B.t.k. Use of TM-BioControl would have no impact on pollinators or these plants. Defoliation in unprotected areas could have a beneficial impact on high light intensity species and a negative impact on shade tolerant species. *The Proposed Action could impact individuals but is not likely to cause a trend toward federal listing.*

UMATILLA NATIONAL FOREST

If protection maintains or increases canopy closure, there could be a beneficial impact on *Cypripedium fasciculatum* habitat. It is unlikely this plant is pollinated by Lepidoptera. Information is not available for other sensitive species. Most *Botrychiums* on this Forest occur in lodgepole pine types, non-host type for DFTM. In unprotected areas, defoliation could cause a negative impact on *Cypripedium fasciculatum* but would have no impact on *Ranunculus populago*, *Bolandra oregana*, or *Botrychiums*. *Overall, there would be no impact on plant habitats from the Proposed Action.*

WALLOWA-WHITMAN NATIONAL FOREST

There is little/no information on Lepidopteran pollinators on the 20 sensitive species in host type. Therefore, potential impacts of B.t.k. on these plants are uncertain. Defoliation of unprotected areas could have a beneficial impact on *Botrychiums*. *Overall, the Proposed Action would have no impact on plant habitats.*

MALHEUR NATIONAL FOREST

Since no Lepidoptera pollinators are known to be essential, the use of either B.t.k. or TM-BioControl is not expected to impact sensitive plant pollinators. In unprotected areas, defoliation could have a beneficial impact on *Luina serpentina* and possibly *Thelypodium ucosomum*. *There would be no overall impact on these plant habitats.*

OCHOCO NATIONAL FOREST

Since Lepidoptera pollinators are not known to be essential for pollination of sensitive plants on the Ochoco, there would likely be no impact to plants in protected areas. There would still be beneficial impacts to light sensitive species in unprotected areas. *Overall, the Proposed Action would have no impact on plant habitats.*

WINEMA NATIONAL FOREST

Approximately 25% of the known *Collomia mazama* population occurs in proposed protection areas. Pollinators are mostly bees; no Lepidopteran pollinators have been observed. Since *Collomia* is a long-lived species, it would probably not be impacted by short-term pollinator fluctuations.

Blue-leaved penstemon is a light limited species that tends to become scarce and stunted when canopy closures exceed 40%. Only eight, widely separated populations

have been found in the Pacific Northwest. Habitat for this species is managed so that known populations have sufficient canopy openings for what is believed to be an adequate number and diversity of plants to maintain viability. The clear winged sphinx moth, *Hemeris diffinis*, has been seen taking nectar from this plant and represents the most likely long range pollinator. B.t.k. could have a negative impact on the moth. TM-BioControl is unlikely to impact this insect and thus, would probably not impact the plant. Defoliation in unprotected areas could enhance habitat for this species. The Proposed Action could impact individuals but is not likely to cause a trend toward federal listing.

There would be no impact on any of the other sensitive species. *As a result, there would be no overall impact on plant habitats.*

FREMONT NATIONAL FOREST

Blue-leaved penstemon is also found on the Fremont Forest. Effects of the Proposed Action are described for the Winema Forest, above. Green-tinged paintbrush, (*Castilleja chlorotica*) also occurs, primarily in mountain sagebrush communities interspersed with white fir. Lepidoptera are not known pollinators of this species so use of either B.t.k. or TM-BioControl should have no impact on this species. The species is moderately shade tolerant. Where canopies exceed 70% closure, defoliation in unprotected areas could benefit the plant. *Overall, the Proposed Action would have no impact on plant habitats.*

EXPANDED PROTECTION ALTERNATIVE ALL SAME

COLVILLE NATIONAL FOREST

Thirty-five sensitive species are documented or suspected to occur on the Forest. Of these, *Cypripedium parviflorum* occurs in Douglas-fir host types and may occur in some campground areas. There could be a beneficial impact on *Cypripedium fasciculatum* habitat where protection maintains or increases canopy closure. It is unlikely this plant is pollinated by Lepidoptera. Several *Botrychiums* have also been found on the Forest but most are in cedar types or wetlands and are unlikely to be in proposed protection areas. These species are not pollinated by Lepidoptera. *The Expanded Protection Alternative would not impact plant habitat.*

OKANOGAN NATIONAL FOREST

There are no known sensitive plants in proposed protection areas. Additionally, since most of the Forest sensitive species are wind pollinated or pollinated by non-Lepidoptera insects, it is unlikely that there would be any impact on most species. The mountain dandelion, *Agoseris elata*, is known to have a Lepidoptera pollinator but resides in meadows outside proposed protection areas. There would be no impact from defoliation in unprotected areas. *This alternative would have no overall impact on plant habitats.*

WENATCHEE NATIONAL FOREST

Prevention of large-scale defoliation would probably maintain existing shade conditions in the understory. This would be beneficial to shade tolerant or shade dependant species. Potential impacts on pollinators are likely to be more pronounced than in the Proposed Action because of greater application of B.t.k. There would be no impact from use of TM-BioControl. *The Expanded Protection Alternative could impact individuals but is not likely to cause a trend toward federal listing.*

UMATILLA NATIONAL FOREST

There could be a beneficial impact on *Cypripedium fasciculatum* habitat where protection maintains or increases canopy closure. It is unlikely this plant is pollinated by Lepidoptera. Information is unavailable for other sensitive species. Most *Botrychiums* on this Forest occur in lodgepole pine types, non-host type for DFTM. In unprotected areas, defoliation would have no impact on *Ranunculus populago*, *Bolandra oregana*, or *Botrychiums*. *Overall, there would be no impact on plant habitats from the Expanded Protection Alternative.*

WALLOWA-WHITMAN NATIONAL FOREST

Since there is little/no information on pollinators, widespread use of B.t.k. could impact sensitive plants. *Based on current information, the Expanded Protection Alternative would have no impact on plant habitats.*

MALHEUR NATIONAL FOREST

Impacts are the same as the Proposed Action – no impact.

OCHOCO NATIONAL FOREST

Impacts are the same as the Proposed Action – no impact.

WINEMA NATIONAL FOREST

Greater use if B.t.k. could have a more negative effect on blue-leaved penstemon pollinators. As discussed previously, there would be no impact in protected or unprotected areas on *Collomia mazama* or other sensitive species. *There would be no overall impact of the Expanded Protection Alternative on plant habitats.*

FREMONT NATIONAL FOREST

Greater use if B.t.k. could have a more negative effect on blue-leaved penstemon pollinators. There would be no impact in protected or unprotected areas on other sensitive species. *The Expanded Protection Alternative would have no impact of on plant habitats.*

TM-BIOCONTROL ALTERNATIVE

COLVILLE NATIONAL FOREST

Impacts are the same as the Proposed Action – *no impact.*

OKANOGAN NATIONAL FOREST

Impacts are the same as the Proposed Action – *no impact.*

WENATCHEE NATIONAL FOREST

Use of TM-BioControl would have no impact on pollinators or plants. Defoliation in unprotected areas

could have a beneficial impact on high light intensity species. *This alternative would have no impact on plant habitats.*

UMATILLA NATIONAL FOREST

Impacts are the same as the Proposed Action – *no impact.*

WALLOWA-WHITMAN NATIONAL FOREST

Use of TM-BioControl only is unlikely to impact pollinators of proposed, threatened, or endangered species on the Wallowa-Whitman. *There would be no impact on plant habitats from this alternative.*

MALHEUR NATIONAL FOREST

Impacts are the same as the Proposed Action – *no impact.*

OCHOCO NATIONAL FOREST

TM-BioControl is unlikely to impact Lepidopteran pollinators of sensitive plant species on the Ochoco. *There would be no impact on plant habitats from this alternative.*

WINEMA NATIONAL FOREST

TM-BioControl is unlikely to impact Lepidopteran pollinators of sensitive plant species. *There would be no impact on plant habitats from this alternative.*

FREMONT NATIONAL FOREST

TM-BioControl is unlikely to impact Lepidopteran pollinators of sensitive plant species. *There would be no impact on plant habitats from this alternative.*

PLANTS – OTHER SPECIES

NO ACTION ALTERNATIVE

OKANOGAN & WENATCHEE NATIONAL FORESTS

Candy stick (*Allotropa virgata*) is a shade dependent species that lives (probably as a saprophyte) in the understory of Douglas-fir and true fir types. Extensive tree mortality could increase light intensity, negatively affecting this plant. Most *Botrychiums* on this Forest occur in non-host type. *The overall effect of the No Action Alternative would be negative.*

WINEMA NATIONAL FOREST

Cypripedium montanum and various fungi could be negatively impacted by extensive defoliation that resulted in increased light levels to the understory. The No Action Alternative would have a negative effect on plant habitats.

ALL OTHER FORESTS

There are no “Survey and Manage” plant species or other species of concern on the Colville, Umatilla, Wallowa-Whitman, Malheur, Ochoco, or Fremont National Forests.

PROPOSED ACTION

OKANOGAN & WENATCHEE NATIONAL FORESTS

It is doubtful that there are any Lepidopteran pollinators of *Allotropa virgata*. *Botrychiums* could benefit from canopy

openings. Biotrophic fungi that require a living host could be affected by extensive tree mortality. The fungus *Bridgeporus nobilissimus* occurs in the noble fir zone but out of proposed protection areas. Survey and Manage lichens and most bryophytes are not in proposed protection zones. None of these species has Lepidopteran spore transmittal agents *so there would be no effect from use of either B.t.k. or TM-BioControl.*

WINEMA NATIONAL FOREST

Several survey and manage fungi species occur in proposed protection areas, specifically *Ramaria rubravanescens* which is found near Mares Egg Springs. Potential effects from changes in overstory closure are unknown. *Polyozelus multiplex*, *Nevadogastrum nubigenum*, *Ptelidium californica*, and *Plectania milleri* all occur in proposed protection areas sites. There are no known Lepidopteran spore transmittal agents. Implementation of the Proposed Action would maintain existing conditions. *There would be no effect from this action.*

ALL OTHER FORESTS

There are no “Survey and Manage” plant species or other species of concern on the Colville, Umatilla, Wallowa-Whitman, Malheur, Ochoco, or Fremont National Forests.

EXPANDED PROTECTION ALTERNATIVE

OKANOGAN & WENATCHEE NATIONAL FORESTS

Effects are the same as the Proposed Action – *no effects.*

WINEMA NATIONAL FOREST

Effects are the same as the Proposed Action – *no effects.*

ALL OTHER FORESTS

There are no “Survey and Manage” plant species or other species of concern on the Colville, Umatilla, Wallowa-Whitman, Malheur, Ochoco, or Fremont National Forests.

TM-BIOCONTROL ALTERNATIVE

OKANOGAN & WENATCHEE NATIONAL FORESTS

Effects are the same as the Proposed Action – *no effects.*

WINEMA NATIONAL FOREST

Effects are the same as the Proposed Action – *no effects.*

ALL OTHER FORESTS

There are no “Survey and Manage” plant species or other species of concern on the Colville, Umatilla, Wallowa-Whitman, Malheur, Ochoco, or Fremont National Forests.

HUMAN ENVIRONMENT: HEALTH

An in-depth risk assessment was done for B.t.k. in the 1995 *Programmatic Gypsy Moth Environmental Impact Statement*; much of that information is incorporated by reference in this analysis. An in-depth risk assessment was also done for TM-BioControl (SERA, 1999); that information is also used in this analysis. The *Gypsy Moth EIS* also includes an analysis of Gypchek, which is the gypsy moth nucleopolyhedrosis virus equivalent to TM-BioControl. Some of the analysis for Gypchek in the *Gypsy Moth EIS* is inferred for TM-BioControl. Since gypsy moth (*Lymantria dispar* L.) is closely related to Douglas-fir tussock moth, some of the impacts from gypsy moth were inferred in the analysis of potential impacts from Douglas-fir tussock moth. Please see Appendix H for a more detailed discussion of the Human Health analysis.

The risk assessments used in this analysis considered the potential adverse human health effects from exposure to Douglas-fir tussock moth, B.t.k., and TM-BioControl. It was found that all cause the same general types of effects: skin, eye, or respiratory tract irritations. These effects are not life threatening or debilitating, and are reversible. Under routine conditions of exposure, the only agent likely to cause a substantial number of adverse health effects is the Douglas-fir tussock moth. Under extreme conditions, the use of B.t.k. could be associated with some irritant effects in some members of the public.

NO ACTION

ALL FORESTS

Human contact with hairs of Douglas-fir tussock moth larvae can cause an allergic reaction called "Tussockosis". Symptoms include skin, eye, and respiratory tract irritations and may require medical attention. People who work in the woods tend to have significant reactions; even mill workers handling forest products can develop Tussockosis. People who are sensitive or allergic to other insects tend to be more sensitive to DFTM (Perlman, et al., 1976). Many people also find the overwhelming number of tussock moth larvae annoying. During an outbreak, there can be as many as 300,000 larvae/acre (SERA, 1999). This estimate is based on populations that are considerably lower than those in the 1972 - 1973 outbreak were. In a 1998 outbreak in a National Park, people were greatly disturbed by the presence of millions of larvae feeding on trees and raining fecal material onto them and their property (USDI, 1999).

As the density of the caterpillar population in an area increases, the risk of exposure to the insect also increases. For this analysis, those most likely to be exposed to DFTM would work, visit, or recreate in an infested area. The risk of human exposure is associated with the probability of coming in contact with larvae, cocoons, or eggs masses of the Douglas-fir tussock moth. For most people, there is a



41-83% chance of developing a skin rash after confirmed contact (Perlman, et al, 1976). Young children appear to exhibit more reactions than adults do, probably because they are more sensitive or because they spend more time outdoors.

Experience has shown that people who work in tussock moth-infested areas are affected more than are recreational visitors, especially in regard to allergic reactions. One study documenting the effects of a severe outbreak of the 1973 Douglas-fir tussock moth in Oregon and Washington observed that "occupational groups, including lumber mill workers, Forestry workers, and loggers experienced allergic response rates of 41, 44, and 83 percent, respectively, compared with a response rate

of 22 percent in a group of presumably unexposed workers (Perlman et al. 1976; Press et al. 1977 in SERA 1999)." There were also reports that the garbage collectors suffered skin irritation from contacting the poisonous hairs of the caterpillar. The most severe exposures for loggers were characterized as "almost a rain of toxic and allergenic fallout (SERA 1999)." Many loggers with no history of allergies complained of skin rashes or welts, suggesting that the insect parts may contain both primary irritants as well as allergenic materials. Major reported effects included irritation to the skin, eyes, and respiratory tract (SERA 1999). A National Park study found that in a 1998 outbreak, about 30 to 40 Kings Canyon National Park Service and concession employees suffered symptoms of Tussockosis; five filed workmen compensation claims for treatment by a physician. The study notes, "One individual became so sensitized to the allergen that merely driving through the outbreak area produced symptoms including itchy, watery eyes and shortness of breath (USDI 1999)." The Park Service felt that Tussockosis could be such a problem with their field employees that visitor areas might be closed because of the risk posed to Park Service employees staffing those areas (USDI 1999).

PROPOSED ACTION

ALL FORESTS

Effects of B.t.k. on People

The most common effects from exposure to B.t.k. are eye, skin, and respiratory tract irritation. Under usual conditions, B.t.k. does not pose a substantial risk to workers or the public. As with any preparation containing microorganisms, concerns include pathogenicity, persistence of the microorganism in the human body, genetic stability of the microorganism in the environment, and ability of the microbial agent to interact with other microorganisms. B.t.k. formulas are complex and may have toxic properties that are unrelated to the presence of B.t.k. It is unclear, however, if effects on humans are caused by the microorganism or by the other compounds (inert ingredients) in the formula. The EPA concluded B.t.k. is not a human pathogen; the British Columbia

Ministry of Health concluded that B.t.k. is specific to Lepidopteran caterpillars and does not pose a threat to humans.

The composition of inert ingredients in the commercial formulations of B.t.k. and their significance to public health is a matter of concern. Although the identities and quantities of inert ingredients are proprietary information, all are generally recognized as safe by EPA. Additives in the preparation known commercially as Foray 48B are approved for use in foods in both the U.S. and Canada. All inert compounds have been reviewed by EPA and various agencies in Canada (USDA, 1995). In addition, the Oregon Department of Human Resources reviewed Foray 48B and determined that exposure to Foray 48B would be unlikely to pose a public health risk (Flemming, 1993, cited in USDA, 1995). In preparation of the risk assessment for the Gypsy Moth EIS, EPA files on product chemistry were reviewed for all B.t.k. formulations.

The aerial and ground methods of spraying B.t.k. suggest that the likeliest routes of exposure by the public are through the mouth, skin, and respiratory tract. Accidental exposures through the eyes could occur in workers. During ground spraying, workers could be exposed to high levels of B.t.k. Variables that influence actual exposure rates are concentration of B.t.k., specific application methods, duration of exposure, and the type of job. For workers, skin contact with B.t.k. suspended in air is the primary exposure concern. Epidemiological studies have not detected any adverse effects to the exposed people. In addition, a surveillance program by family physicians noted no substantial difference in the reports of symptoms that might be associated with B.t.k. exposure in versus outside the spray area (cited in USDA, 1995; Capital Health Region Office, 1999). Based on these studies and the long history of use, no hazard has been identified for members of the public exposed to B.t.k.

Little information is available on groups with special sensitivities, such as allergies or chemical sensitivities, to B.t.k. In British Columbia, only a weak relationship was noted in the incidence of irritant effects between ground workers with and without a history of asthma, seasonal allergies, or eczema (Cook, 1994, cited in USDA, 1995). In a more detailed study, asthmatic children both in and out of the spray zone were monitored before, during, and after aerial applications of B.t.k. Children in the spray zone did not have more symptoms than those outside the spray zone (Capital Health Region Office, 1999). Finally, workers or members of the public who are exposed to B.t.k. would also be exposed to the Douglas-fir tussock moth.

Studies of possible cumulative effects have tried to consider both residual exposure to B.t.k. formulas after a single application and the effects of multiple applications in a single season and over several years. In the Douglas-fir tussock moth project, the only group likely to be subject to successive years of exposure would be workers who happened to work on successive projects in different areas.

In this respect, no cumulative effects from spray programs conducted over several years are anticipated.

Effects of TM-BioControl on People

Douglas-fir tussock moth virus occurs naturally and is responsible for the collapse of most DFTM outbreaks. TM-BioControl is a powdered formulation of the virus, developed and registered by the USDA Forest Service for control of Douglas-fir tussock moth. It is produced by the *in vivo* culture of infected DFTM larvae. Therefore, most (about 89%) of the formula consists of ground tussock moth caterpillar parts. The TM-BioControl powder is mixed with water, molasses, a sunscreen, and a sticking agent, and is applied at the rate of 1-2 gallons per acre. In some instances, TM-BioControl may be mixed with a premixed carrier called Carrier 038. All of the components of Carrier 038 are on the EPA list as Generally Recognized As Safe; all are exempt from residue tolerances under Chapter 40 of the Code of Federal Regulations, Section 180.1001. Most of the components are complex natural products and are not chemically defined.

TM-BioControl is known to cause skin, eye, and respiratory tract irritation in humans. Most of the available mammalian toxicity data on TM-BioControl was generated in the mid-1970s as part of the registration. The available data regarding the effects of exposure suggest that the irritant effects are probably due to the occurrence of insect parts in the TM-BioControl formulation.

During re-registration of TM-BioControl, the EPA determined that formal exposure assessments for the public and workers were not required because of the lack of any apparent systemic toxic effects and because the use of TM-BioControl would not substantially increase ambient levels of either the natural virus or insect larval parts. It appears the protection of a severe Douglas-fir tussock moth infestation with TM-BioControl would increase the environmental levels of the virus by less than 3%. In addition, the use of TM-BioControl to prevent a severe infestation would reduce eventual exposures to both the virus and insect larvae. For these reasons, use of TM-BioControl may be beneficial rather than potentially detrimental to members of the public.

There is no basis for asserting that workers are subject to any risk of systemic adverse effects from the use of TM-BioControl. Nonetheless, workers involved in the mixing of TM-BioControl are required to take reasonable measures and use personal protective equipment to limit the potential for introducing the formulation into their eyes. If members of the public were exposed to a spray of TM-BioControl, the primary concern would be the insect parts in the formulation. There is a low apparent risk associated with just one application of TM-BioControl. Because of the fast acting nature of the virus, area would not be protected more than once, either during the same year or in successive years; repeated exposure is not expected. Individuals with pre-existing allergies may be at greater risk of effects from TM-BioControl.

EXPANDED PROTECTION ALTERNATIVE

ALL FORESTS

Same effects for B.t.k. & TM-BioControl as in the Proposed Action, however, there would be more exposure to humans.

TM-BIOCONTROL ONLY ALTERNATIVE

ALL FORESTS

Same effects to humans as the Proposed Action for TM-BioControl. No B.t.k. would be used.

HUMAN ENVIRONMENT: MUNICIPAL WATERSHEDS

NO ACTION

ALL FORESTS

Heavy defoliation and subsequent mortality could occur in all municipal watersheds. Insect activity and defoliation could cause users to raise water quality and quantity concerns. However, the actual effect on these watersheds is expected to be minor and on a scale too small to measure by conventional means. During heavy defoliation, water quality may be affected by direct contamination with frass (insect fecal matter). As an example, during a gypsy moth outbreak while caterpillars were feeding, levels of fecal streptococci and fecal coliform increased significantly. No adverse effects were reported, however. Similar short-term increases in these levels could be expected with DFTM defoliation as well.

Increased fuel loads from defoliation and additional tree mortality from bark beetles will increase the risk for subsequent high intensity fires, which could affect water quality and sedimentation in streams. There is a significant amount of host type in each watershed (from 47 to 61 percent of the National Forest land area in each watershed), increasing the probability of effect from an outbreak. The likelihood of fire occurrence in the watersheds in any given year immediately following the defoliation may not be high, but the consequences of a fire event in the first several years after an outbreak would be significant. The cumulative probability of a fire event during the several decade period following an outbreak is high, and fire severity would be high, thus the consequences of a fire would also be significant. Secondary mortality from bark beetles is likely, particularly in the Tiger Canyon and the Mill Creek watersheds where there are existing Douglas-fir beetle outbreaks.

PROPOSED ACTION

ALL FORESTS

This alternative would protect municipal watersheds from defoliation. There would be no change in sediment, nitrogen, or peak flows regimes because of a tussock moth outbreak. This action would reduce the risk of potential fuel buildup that would result from an outbreak, and the

subsequent possibility of sedimentation and peak flows that would result from high intensity fires.

EXPANDED PROTECTION ALTERNATIVE

ALL FORESTS

This alternative would protect municipal watersheds from defoliation. There would be no change in sediment, nitrogen, or peak flows regimes from a tussock moth outbreak. This action would reduce the risk of potential fuel buildup that would result from an outbreak, and the subsequent possibility of sedimentation and peak flows that would result from high intensity fires.

TM-BIOCONTROL ONLY ALTERNATIVE

ALL FORESTS

This alternative would protect municipal watersheds from defoliation. There would be no change in sediment, nitrogen, or peak flows regimes because of a tussock moth outbreak. This action would reduce the risk of potential fuel buildup that would result from an outbreak, and the subsequent possibility of sedimentation and peak flows that would result from high intensity fires.



HUMAN ENVIRONMENT: RECREATION, RESIDENTIAL & ADMINISTRATIVE SITES

NO ACTION

ALL FORESTS

The effect of tussock moth damage on high-use recreation sites would likely be more severe than in areas where recreation is dispersed over larger areas. Recreation sites tend to have high levels of investment in infrastructure and services, leading to proportionally high losses in recreation value from the physical damage and nuisance effects of a tussock moth outbreak. Recreation sites include campgrounds, summer home areas, organization camps, visitor centers, viewpoints, and other places of concentrated recreation use. Campers are often the first to complain about the presence of the tussock moth. Larvae and their fecal pellets fall on picnic tables, cars, and tents, causing considerable annoyance to campers (Wickman & Renton 1975). Sites that are especially unique, popular or have high capacity may suffer the most loss because comparable substitute sites are not available. A good

example of this situation is a National Park. Nuisance effects from a 1998 Douglas-fir tussock moth outbreak experienced at Sequoia/Kings Canyon National Park in California include: reduced camper nights and revenue; reduced overnight stays in lodging businesses; reduced number and duration of day-use visitors; loss of revenue for concessionaires because of lower day use; and revenue losses to private businesses that serve receptionists. The National Park Service found a decline of nearly 2,000 occupied overnight camping spaces for the period July 1 - September 10, 1999. Due to nuisance effects, the National Park Service found that concessions operators were granting refunds when requested by guests who considered the rooms in the lodge unsatisfactory because of the presence of caterpillars (USDI 1999). Saddle stock in the Park was also affected. A commercial stable operator closed four weeks early because of the problems encountered in dealing with the outbreak, resulting in an estimated \$20,000 loss in gross revenues (USDI 1999). The Park Service believed that many camping parties had intended to spend more than one night in the area left early because of the highly visible effects of the larval population. Approximately 100 visitors requested medical assistance or advice because of skin rashes or other minor allergic reactions over the course of the summer, believed to be associated with Tussockosis. A few visitors requested a refund of camping fees after spending a night.

Costs associated with tree damage in recreation sites include the diminished recreation experience and the cost of removing and replacing lost trees. Studies show that larger trees and a variety of tree species are positively correlated with higher benefit levels. The presence of visible damage, dead, and dying trees, and smaller average tree size that can result from tussock moth damage has an impact on recreation (Rosenberger, 1997). The impact of insects feeding on trees in recreation sites needs to be evaluated by the loss of shade, screening, and esthetic qualities. Dead trees and tops from top-killed trees often need to be removed from recreation sites because they are hazardous. The costs of removing hazardous trees are in addition to the replacement costs associated with restoring vegetation in camp units (Wickman & Renton 1975). Because of the lost amenity values, neither the hazard removal cost nor the replacement cost may adequately represent the lost recreation benefits associated with damaged sites. For example, Sequoia and Kings Canyon National Parks, predicted "many trees would be lost in the campground and other development areas. Many of these would be large, old-growth trees, which would not be replaceable in our time (USDI 1999)." Generally, the loss of recreation benefits would accrue until replacement trees grow to sufficient size to mitigate the damage caused by the insects (Wickman and Renton 1975)."

Residential and administrative sites include offices, work centers, residences, summer homes, organization camps, resorts, and other places where people work and live in the boundaries of National Forest System lands. These sites are prone to similar types of health and nuisance problems from the tussock moth that afflict high use recreation sites,

but to a greater degree, residential and administrative sites are generally permanent sites that cannot be reasonably avoided in favor of alternate locations during a tussock moth outbreak. If unable to temporarily relocate or suspend occupancy, people either suffer from exposure to the insect or absorb a substantial loss or inconvenience by staying away. The principal values at risk of health and nuisance effects include recreation benefits (organization camps, summer homes and resorts) and occupational safety (offices, work centers and other facilities or sites staffed by federal employees, contractors, and volunteers, and private sector workers).

Like recreation sites, residential and administrative sites are at risk of physical tree damage or death, including similar losses of the shade, screening, and esthetic benefits associated with trees. In addition, like recreation sites, there is a cost to remove and replace damaged or dead trees. There is obviously considerable overlap among recreation sites and administrative sites because people often live and work in the same areas that people recreate. In addition, like some recreation sites, these areas can have considerable investment in infrastructure. The overall value of the site can be diminished by the loss of trees, especially in the short term.

PROPOSED ACTION

ALL FORESTS

Residential and administrative sites would be protected from high populations of Douglas-fir tussock moth. All high-use recreation sites would also be protected. Application effectiveness is expected to be high. In most cases, all existing benefits from these Forest uses would continue.

EXPANDED PROTECTION ALTERNATIVE

ALL FORESTS

This alternative provides the same protection to residential and administrative sites as the Proposed Action and greater protection for forest workers because more sites could be protected. Records from previous outbreaks indicate many Forest workers suffer severe allergic reactions to tussock moth larvae. As the protection area grows, there is less risk that Forest workers would be exposed to the highly allergenic larvae. All high-use recreation sites would also be protected. In most cases, all existing benefits from these Forest uses would continue.

TM-BIOCONTROL ONLY ALTERNATIVE

ALL FORESTS

Residential and administrative sites would be protected from high populations of Douglas-fir tussock moth. All high-use recreation sites would also be protected. Application effectiveness is expected to be high. In most cases, all existing benefits from these Forest uses would continue.

HUMAN ENVIRONMENT: SCENIC AREAS

NO ACTION

ALL FORESTS

Scenic views would not be protected with this alternative. The extent of damage would generally be proportional to the number of acres at risk, and eventually infested. Generally, the more intensively used and viewed a landscape is, the larger the levels of scenic benefits are at risk. Damage to foreground views would be greater than to background views because their relative closeness makes changes in vegetation more evident. In extreme cases, foreground views could be substantially harmed. However, previous damage patterns suggest that most effects would be minor and of short duration. Impacts on backdrop views are expected to be low.

PROPOSED ACTION

ALL FORESTS

This alternative would protect all foreground scenic Areas of Concern to prevent or minimize damage to these landscape views.

EXPANDED PROTECTION ALTERNATIVE

ALL FORESTS

In addition to foreground scenic views protected in the Proposed Action, this alternative would also protect middle and background views. However, since the overall impact of DFTM on backdrop scenic views is expected to be low, the gain from protecting these additional areas is also expected to be low.

TM-BIOCONTROL ONLY ALTERNATIVE

ALL FORESTS

This alternative would protect all foreground scenic Areas of Concern to prevent or minimize damage to these landscape views.

ISSUE 1: HUMAN HEALTH EFFECTS

NO ACTION ALTERNATIVE

In this alternative, individuals would not be exposed to the effects of B.t.k. or TM-BioControl. However, people recreating and working in infested areas would be exposed to the irritant effects of the Douglas-fir tussock moth. Based on previous data, approximately 25%-40% of the public and 41% to 75% of the workers would experience reactions.

PROPOSED ACTION

This alternative identifies protecting specific Areas of Concern. Some areas would be protected with TM-BioControl and some would be protected with B.t.k. Many of the proposed protection areas are remote. For the most part, the public would not be exposed to the biological control agents. Should individuals be in campgrounds or at administrative sites during direct aerial application, they could experience transient skin, eye, or respiratory tract irritations. Workers would have a higher level of exposure.

Because this alternative does not propose to protect all of the potentially infested areas, and because none of the adjacent state or private lands would be protected, most people would also be exposed to the effects of the Douglas-fir tussock moth. Based on previous data, approximately 25%-40% of the public and 41% to 75% of the workers would experience reactions.

EXPANDED PROTECTION ALTERNATIVE

This alternative proposes to protect Areas of Concern in mentioned in the Proposed Action plus more of the infested general Forest areas. The additional acres would probably be protected with B.t.k. As with the Proposed Action, many of the likely protection areas are remote. For the most part, the public would not be exposed to the protection. Because this alternative proposes to protect more, but not all of the potentially infested areas, and because none of the adjacent state or private lands would be protected, members of the public and workers in these areas would also be exposed to the effects of the Douglas-fir tussock moth in untreated acres.

TM-BIOCONTROL ONLY ALTERNATIVE

In this alternative, individuals would not be exposed to the effects of B.t.k. Exposure to TM-BioControl would be the same as in the Proposed Action. People recreating and working in infested areas would be exposed to the irritant effects of the Douglas-fir tussock moth. Based on previous data, approximately 25%-40% of the public and 41% to 75% of the workers would experience reactions.

ISSUE 2: PROTECTION OF TIMBER VALUES

The value of timber is a function of many factors: wood quality, market conditions, and logging costs. The focus here is on tree mortality as wood quality in dead trees changes over time, and market conditions and logging costs would vary depending on specific timing and location of timbers sales. For these reasons, no attempt to

estimate or analyze the stumpage value was made. However, wood quality and thus the value of the raw material would change by the tussock moth defoliation and by secondary bark beetle infestation with subsequent tree mortality.

Over time, the wood quality in the dead trees would deteriorate so that by the end of 3 to 8 years, the log loses its value as saw material. Total defoliation on all host type trees is not expected, but over the landscape, an estimate can be made of the proportion of host type that would be totally defoliated or partially defoliated. From that, it is possible to estimate mortality assuming no treatment is done to prevent an outbreak of the insect. Mortality estimates are based on the rules included in Appendix K.

NO ACTION ALTERNATIVE:

No portion of the 2,670,000 acres of merchantable timber in host type would be protected.

PROPOSED ACTION AND TM-BIOCONTROL ALTERNATIVE:

This alternative would protect some trees from defoliation. Areas of Concern include: 1) habitat for species listed through the Endangered Species Act, 2) investments such as seed orchards or developed campgrounds, or 3) areas where there are high concentrations of people such as administrative sites or campgrounds. About 2,139,000 acres of merchantable timber would not be protected. Any of the areas outside the Proposed Action or the TM-BioControl alternative areas that are in host type may see partial or complete defoliation.

EXPANDED PROTECTION ALTERNATIVE:

This alternative would protect trees from defoliation in all areas in the Proposed Alternative plus remaining areas that contain over 60% host type (not including Wilderness). About 794,000 acres of merchantable timber would not be

protected and essentially all that would be in 20-60% host type.

, below, shows a worst-case scenario of mortality by alternative in areas available for harvest. The mortality would occur in areas not being protected and that are available for harvest. These are just estimates, which take into account the risk of the Douglas-fir tussock moth outbreak across the landscape on National Forests in Eastern Washington and Oregon.

A more likely scenario is drawn from the experience of the outbreak during 1972 through 1973 (USDA FS, 1974). That outbreak caused damage on about 700,000 acres or about 16% to 17% of host type areas. Assuming the current expected outbreak takes a similar course and is evenly distributed over the landscape, there would be defoliation on areas available for timber harvest of about 100,000 MBF for the Proposed Action and TM-BioControl Only alternatives, probably less than 100 MBF for Alternative 2, and about 130,000 MBF for the no action alternative.

Mortality actually experienced during the tussock moth outbreak was approximately 588,000 MBF on National Forest lands during the years 1972-73 (USDA FS, 1974). Probably, most of the difference in volume from the 130,000 MBF estimated above is from the fact that it was calculated on all areas in the national Forests. The latter 130,000 MBF is estimated only on areas currently allocated for timber harvest. In addition, standards to enhance wildlife and fish habitat as well as other resources have decreased volume available on a per acre basis.

Table IV-8: Worst-case mortality, in thousand board feet

	NO ACTION ALT.	PROPOSED ACTION & TM-BIOCONTROL ALT.	EXPANDED PROTECTION ALT.
Colville	105,076	102,338	33
Okanogan	22,901	18,821	1
Wenatchee	48,380	13,838	2
Umatilla	250,995	200,809	7
W-W	264,582	209,836	20
Malheur	45,124	34,345	4
Ochoco	52,533	8,939	< 1
Winema	4,486	3,396	2
Fremont (Demming Crk. Only)	117	11	< 1
Total	794,194	592,333	70

ISSUE 3: EFFECTS ON NON-TARGET LEPIDOPTERA

Effects of Douglas-fir Tussock Moth on other Moths & Butterflies

Refer to the Lepidoptera section on page IV-42 for a more complete discussion of non-target Lepidoptera. A brief summary of that discussion follows:

Since non-target Lepidopterans are affected by B.t.k., the populations of many species would decrease for 1 to 2 years. There are no threatened, endangered, or sensitive species in the project area. Five species proposed for listing are found in the project area: Mardon Skipper in Klamath County, OR and 4 species in Washington. Only the Great Arctic would be in a life stage that would cause it to be affected by B.t.k. It lives in coniferous forest openings and meadows, areas where the use of B.t.k. will be avoided, per the Mitigation Measures discussed in Chapter II.

NO ACTION ALTERNATIVE

Under this alternative, there would be no insecticide impacts to non-target Lepidoptera. Competition for food from DFTM could have a short-term effect on other Lepidoptera. This alternative could result in extensive defoliation and subsequent tree mortality over the outbreak area, which could create forest openings where shrubs and grasses would increase habitat for moths and butterflies.

PROPOSED ACTION

This alternative proposes protection with either B.t.k. or TM-BioControl. Some of the non-target Lepidoptera in protection areas would suffer decreases in populations for 1 – 2 years due to the use of B.t.k. To minimize impacts of B.t.k. on non-targets, the Forest Service would use TM-BioControl only in forested areas where these species provide a critical food supply for other wildlife. These areas include streams, spotted owl nest sites, important wildlife habitat areas, and areas that harbor unusual Lepidopteran species. Where possible, areas that have little or no host type, or meadows, and forest edges would be left unprotected as non-target refuges.

Neither B.t.k. nor TM-BioControl would affect Lepidoptera populations in any unprotected areas. Competition for food from DFTM could have a short-term effect on other Lepidoptera.

EXPANDED PROTECTION ALTERNATIVE

Effects on non-target Lepidoptera would be similar to the Proposed Action, except that more acres would be protected with B.t.k. This could cause more short-term impacts on non-target Lepidoptera populations. Overall, impacts would be minimized using precautionary options as stated in the Proposed Action. Competition for food from DFTM might have a short-term effect on other Lepidoptera.

TM-BIOCONTROL ONLY ALTERNATIVE

This alternative proposes protection with TM-BioControl Only. There would be no effects on non-target Lepidoptera other than western and rusty tussock moth. TM-BioControl would not affect Lepidoptera populations in any unprotected areas.

ISSUE 4: MAINTAINING HEALTHY FORESTS

NO ACTION ALTERNATIVE

Stands would not be protected from tussock moth defoliation. Varying levels of defoliation and mortality would be expected. Stands with dense crown closure and high risk of outbreak are generally dry, overstocked sites with low vigor and high susceptibility to a variety of Forest pests and pathogens. The highest mortality and most pronounced changes in structure are expected in these stands.

Where substantial defoliation and mortality occurs, restoration efforts could be delayed or rescheduled in response to changes in stand structure and fuel load.

PROPOSED ACTION

High-risk protected stands would continue to experience declining vigor due to overstocking. Susceptibility to defoliating insects, bark beetles, and root diseases would remain high unless stocking control and species composition was changed through other means (Wickman et al. 1986). Protected stands at moderate risk would generally maintain current rates of growth and development.

In unprotected high and moderate risk stands, significant defoliation and mortality is expected. Bark beetles attracted to stressed trees could cause additional mortality (Wickman, 1963). Eventually, this could create sufficient openings to change stand conditions. Changes would be most evident in high risk stands where defoliation and subsequent mortality would be greatest. Little or no change in stand dynamics is expected in low risk stands.

In summary, implementation of this alternative would retain canopy cover on 236,000 acres of high-risk dry Forest where defoliation would result in damage to Areas of Concern. Retaining host type on these acres would be a short-term strategy until other Forest health restoration efforts could be implemented. Where substantial defoliation and mortality occurs, restoration efforts could be delayed or rescheduled in response to changes in stand structure and fuel load.

EXPANDED PROTECTION ALTERNATIVE

In addition to the areas protected in the Proposed Action, all 60-100% host type would be protected to prevent defoliation if an outbreak occurs. Dense host type Forests on dry sites would continue to experience declining vigor. Susceptibility to defoliating insects, bark beetles, and root diseases would remain high. Eventually, one of these disturbance agents or wildfire would remove most of the host type, reduce crown closure, and initiate stand regeneration (Wickman et al, 1986). Non-host species

such as ponderosa pine and larch would increase after the outbreak. Unless measures were taken to later reduce stocking of naturally regenerating firs, pines and larch would eventually be replaced, starting the tussock moth cycle over again.

TM-BIOCONTROL ONLY ALTERNATIVE

Effects would be the same as the Proposed Action.

ISSUE 5: FUEL BUILD-UP AND FIRE RISK

From a fire fuel standpoint, No Action would result in the highest fuel buildup over the next 15 years. The Proposed Action would protect about 13% of the acres expected to The Expanded Protection Alternative would protect 55% to 60%. The effects for the TM-BioControl Only alternative are the same as the Proposed Action. In all unprotected areas, Forest fuels will continue to accumulate, increasing the risk of ignition and catastrophic fire. The amount of protection is inversely proportional to the risk of fire in the next 15 years



ISSUE 6: EFFECTS OF SPRAYING ON FISH AND WILDLIFE

Field applications of B.t.k. and TM-BioControl would result in direct and indirect exposures to some non-target organisms. Exposure could result in absorption through cuticle or skin, ingestion, or inhalation. Potential effects on specific species were discussed previously. For information on threatened and endangered species, refer to pages IV-15 and IV-27. For effects on sensitive species, please refer to Table IV-6 on page IV-33 and the discussion that follows. For information on Survey and Manage Species, refer to page IV-35. For information on all other wildlife, refer to page IV-36.

Effects of B.t.k. on Fish and Wildlife

The U.S. Environmental Protection Agency (EPA) has concluded that toxicity and infectivity risks of B.t.k. to non-target avian, freshwater fish, freshwater aquatic invertebrates, arthropod predators/parasites, honey bees, annelids and mammalian wildlife is minimal to nonexistent at the label use rates of registered B.t.k. (EPA, 1998). Due to the relatively short half-life of B.t.k., the exposure and subsequent risk to non-target wildlife is limited to the time immediately after application (EPA, 1998). B.t.k. toxins degrade rapidly when exposed to sunlight. As a result, exposure to most above-ground non-target organisms is expected to be minimal.

Vertebrates are not susceptible to B.t.k. toxicity because the mode of action precludes any concern for dermal and inhalation routes (USDA, 1995). A wide range of studies has been conducted on test animals, using several routes of exposure. The results of these tests suggest the use of B.t.k. produces few, if any, negative effects. B.t.k. did not have acute toxicity in tests conducted on experimental birds, dogs, guinea pigs, mice, rats, and other animals. (Extension Toxicology Network 1988). Acute toxicity studies performed on laboratory rodents indicated that there are unlikely to be any adverse effects on wild mammals (EPA 1998).

B.t.k. is toxic to bees and earthworms but only at doses greater than expected in normal pesticide applications (USDA, 1995). Among the susceptible non-target insect populations, recovery takes place soon after cessation of pesticide use (EPA, 1998).

The lack of any documented fish kills, despite the use of B.t.k. in Canadian Forestry and agricultural control programs for nearly 20 years, has been advanced as an argument that B.t.k. does not kill fish (USDA, 1995). Field studies on B.t.k.-contaminated water found no observable effects on resident fish behavior or reproduction. No toxicity or pathogenicity was evident in bluegill or rainbow trout with B.t.k. (EPA, 1998). B.t.k. has also not been shown to bio-accumulate in fish (USDA, 1995). Field observations of brook trout, common white suckers, and small mouth bass did not reveal adverse effects one month after aerial application of B.t.k. (Extension Toxicology Network 1988). An extensive study published in 1990 by Environment Ontario detailed the results of a 10-year effort to examine the effects of B.t.k. on the aquatic environment. Much of the study examined anadromous and resident trout species and concluded that B.t.k. did not have a detrimental effect on reproduction, growth, or the general health of stream trout (Surgeoner & Farkas, 1990). No unreasonable risk to freshwater fish is expected from use of B.t.k. (EPA 1998).

B.t.k. has not been observed to have negative effects on frogs and salamanders (Extension Toxicology Network 1988). While no toxicity data is available on reptiles and amphibians, B.t.k. is not believed to pose a hazard to these organisms either (EPA 1998).

A study of the effects of B.t.k. on soil micro-fauna found a moderate increase in the number of soil bacteria, actinomycetes, fungi, and nematodes. In another study, B.t.k. was found to reduce populations of a predatory mite species (USDA 1995).

Effects of TM-BioControl on Fish and Wildlife

The application of TM-BioControl can be expected to result in exposure to a wide variety of birds, mammals, fish, and aquatic invertebrates. All available avian and aquatic data, and other relevant literature and information, show that the virus does not cause adverse pathogenic or toxic effects on avian, mammalian, or aquatic wildlife (EPA 1996). A study to assess the pathogenicity of virus in rainbow trout fry showed that no toxicity was apparent (SERA 1999). In another study, Chinook salmon, Coho salmon, and steelhead trout showed no effects when exposed to the virus by three different routes (Banowetz, 1976). No mortality were seen when the virus was fed to mallard ducks, house sparrows, bobwhite quail, and black-capped chickadees. No adverse effects were seen in brown trout, bluegill sunfish, and a variety of aquatic invertebrates. Similarly, tests with mule deer, Virginia opossums, short-tailed shrews and white-footed mice, resulted in no evidence of pathogenicity or toxicity (EPA 1996). Scientific literature also demonstrates that the virus

does not have adverse effects on honeybees and does not pose a significant risk to non-target insects (EPA 1996).

Due to the lack of adverse effects on avian, mammalian, and aquatic wildlife, plants, and non-target insects, EPA has found TM-BioControl poses minimal to no risk to non-target wildlife, including endangered species (EPA 1996).

ISSUE 7: WATER QUALITY

As mentioned in the discussion on Water Quality, page IV-13, there are three water quality criteria that could be affected by tussock moth defoliation. They are stream temperature, sedimentation, and nitrogen. Several factors affect stream temperature (degree of defoliation, width, stream orientation, topography and channel characteristics), one of which is defoliation. Host type of 60% or greater would be needed to have a significant effect on temperature.

NO ACTION ALTERNATIVE

About 4,750 miles of streams would be unprotected in 60%-100% host type. Of these, 1,550 miles are 303(d) listed for temperature and 70 miles are listed for sedimentation. There would be no significant changes due to defoliation on nitrogen levels or sedimentation. Cumulative effects include the increased risk of fire and severity of fire. If severe or moderate defoliation occurs, fuel availability, risk of ignition, and risk of larger fires could increase. If there was a severe fire after defoliation, there could be an increase in sedimentation.

PROPOSED ACTION

About 942 miles of streams with 60%-100% host type would be protected. That leaves about 5,700 miles unprotected. The potential for defoliation that could cause increased temperature in streams is less than the No Action alternative but the opportunity is still significant. The risk of fire described in the No Action alternative is less, but is still therein unprotected areas. However, the Areas of Concern as described in the Proposed Action would be removed from an increased risk.

EXPANDED PROTECTION ALTERNATIVE

About 4,990 miles of streams with 60%-100% host type would be protected. Around 710 miles would be left unprotected. This significantly reduces overall exposure for defoliation caused temperature increases and the risk of increased sedimentation from possible increased risk of fire.

TM-BIO-CONTROL ONLY ALTERNATIVE

The effects are the same as the Proposed Action.

ISSUE 8: ECONOMIC EFFECTS FROM DECREASED TOURISM

NO ACTION ALTERNATIVE

The effect of tussock moth damage on high-use recreation sites would likely be more severe than in areas where recreation is dispersed over larger areas. Generally, the more intensively used and viewed a landscape is, the larger

levels of scenic benefits at risk (Rosenberger, 1998).

Recreation sites tend to have high levels of investment in infrastructure and services, leading to proportionally high losses in recreation value from the physical damage and nuisance effects of a tussock moth outbreak. Recreation sites include campgrounds, summer home areas, organization camps, visitor centers, viewpoints, and other places of concentrated recreation use. Campers are often the first to complain about the presence of the tussock moth. Larvae and their fecal pellets fall on picnic tables, cars, and tents, causing considerable annoyance to campers (Wickman & Renton 1975). Sites that are especially unique, popular or have high capacity may suffer the most loss because comparable substitute sites are not available. A good example of this situation is a National Park. Nuisance effects from a 1998 Douglas-fir tussock moth outbreak experienced at Kings Canyon National Park in California include: reduced camper nights and revenue; reduced overnight stays in lodging businesses; reduced number and duration of day-use visitors; loss of revenue for concessionaires because of lower day use; and revenue losses to private businesses that serve receptionists. The National Park Service found a decline of nearly 2,000 occupied overnight camping spaces for the period July 1 - September 10, 1999. Due to nuisance effects, the National Park Service found that concessions operators were granting refunds when requested by guests who considered the rooms in the lodge unsatisfactory because of the presence of caterpillars (USDI 1999). Saddle stock in the Park was also affected. A commercial stable operator closed four weeks early because of the problems encountered in dealing with the outbreak, resulting in an estimated \$20,000 loss in gross revenues (USDI 1999). The Park Service believed that many camping parties had intended to spend more than one night in the area left early because of the highly visible effects of the larval population. Approximately 100 visitors requested medical assistance or advice because of skin rashes or other minor allergic reactions over the course of the summer, believed to be associated with Tussockosis. A few visitors requested a refund of camping fees after spending a night.

Costs associated with tree damage in recreation sites include the diminished recreation experience and the cost of removing and replacing lost trees. Studies show that larger trees and a variety of tree species are positively correlated with higher benefit levels. The presence of visible damage, dead, and dying trees, and smaller average tree size that can result from tussock moth damage has an impact on recreation (Rosenberger, 1997). The impact of insects feeding on trees in recreation sites needs to be evaluated in terms of the loss of shade, screening, and esthetic qualities. Dead trees and tops from top-killed trees often need to be removed from recreation sites because they are hazardous. The costs of removing hazardous trees are in addition to the replacement costs associated with restoring vegetation in camp units (Wickman & Renton 1975). Because of the lost amenity values, neither the hazard removal cost nor the replacement cost may adequately represent the lost

recreation benefits associated with damaged sites. For example, Sequoia and Kings Canyon National Parks, predicted "many trees would be lost in the campground and other development areas. Many of these would be large, old-growth trees, which would not be replaceable in our time (USDI 1999)." Generally, the loss of recreation benefits would accrue until replacement trees grow to sufficient size to mitigate the damage caused by the insects (Wickman and Renton 1975)."

Substantial numbers of high-use developed areas in host type could be affected on all the forests of eastern Washington and eastern Oregon. No effects are expected in southern Oregon.

PROPOSED ACTION

All high use recreation sites in host type would be protected from tussock moth impacts. The features that attract people to these sites would be preserved and loss of income opportunity to those nearby communities would be less than the No Action alternative. The spray action would generate local income.

EXPANDED PROTECTION ALTERNATIVE

Under this alternative, the effect of tussock moths on people would be minimized and the spray operation could generate local revenue. Economic benefits would be roughly proportional to the number of acres sprayed, though the actual economic benefit cannot be accurately determined.

TM-BIOCONTROL ONLY ALTERNATIVE

The effects are the same as the Proposed Action.

ISSUE 9: DOUGLAS-FIR TUSSOCK MOTH AS A FOOD SUPPLY FOR WILDLIFE

NO ACTION ALTERNATIVE

No Action could result in opportunistic feeding by wildlife on outbreak populations for one or two years. This abundance could increase reproduction and/or survival during the outbreak. When DFTM populations collapsed, wildlife species would return to feeding habits associated with non-outbreak conditions.

PROPOSED ACTION

Protection of selected Areas of Concern would result in returning the insect to non-outbreak levels. Wildlife species that feed on tussock moth would not be able to take advantage of high populations but would continue to eat available tussock moths as part of their normal diets. Unprotected areas with outbreak level populations would be available for opportunistic feeding and could offer the associated benefits.

EXPANDED PROTECTION ALTERNATIVE

Protection activities would return the insect to non-outbreak population levels. Wildlife species that feed on tussock moth would not be able to take advantage of high populations but would continue to eat available DFTMs as part of their normal diets. Since this alternative protects

the maximum area, there would be fewer chances for opportunistic feeding in adjacent areas during the outbreak than other alternatives. Species that feed exclusively on moths and butterflies could experience severe food shortages in areas treated with B.t.k.

TM-BIOCONTROL ONLY ALTERNATIVE

Protection of selected Areas of Concern would result in returning the insect to non-outbreak levels. Wildlife species that feed on tussock moth would not be able to take advantage of high populations but would continue to eat available tussock moths as part of their normal diets. Unprotected areas with outbreak level populations would be available for opportunistic feeding and could offer the associated benefits.

ISSUE 10: OPERATIONS

There is the potential for accidents to occur on insect suppression projects. Increasing the size of the operation also increases the potential for accidents. Based on previous experience, standards, guidelines, and mitigation measures have been designed to prevent or reduce the possibility and impacts of future accidents. Potential accident examples include loss of control or damage to aircraft or the need for the pilot to activate the emergency release system and dump the insecticide load in an unplanned location. High concentrations of fuel and insecticide would be involved. Operation plans would be developed to minimize the opportunity for accidents and to mitigate and contain any spills that did occur. The probably place for spills or accidents is at airports, heliports, and heli-spots where equipment is operating. Accidents could also occur over the project site or in route to the project area. Travel ways could be selected to avoid stream crossings as much as possible.

Increased vehicle traffic could also increase the chances of an accident. Since almost all protection would take place in the early morning, most driving to/from the site would be in the dark or early dawn hours. This could increase the risk for a vehicle accident to occur. Driver safety and training would be addressed in the operations plan, and mitigation measures for local emergency personnel would be addressed in the project operations plan. Project operations spill plans would address appropriate equipment and actions needed in case of a spill.

The agency does not plan to close roads in the project area during operations. However, access could be restricted during actual spraying. Roads in the protection area would probably be posted to inform the public that the area is scheduled for protection. If other operations or activities occur in, or near the protection area, it might be necessary to coordinate with those operators to minimize heavy equipment traffic and accident risk. Access to actual staging areas and heliports would be restricted in order to maintain public safety and security. Daily operation briefings to project personnel would inform them of known activity in the area. Specific mitigation measures would be placed in the project operations plan.

Access and use of campgrounds in protection areas may be posted or restricted to minimize exposure to spray and to reduce potential accidents. Specific mitigation measures would be developed in the operations plan for these sites.

In order to minimize drift and achieve effective protection, operations aircraft generally fly low, often in 50 – 75' of the tree canopy. Depending on the size of the protection block, two spray aircraft could fly in tandem. An observation aircraft might also be used. The biological control agents would be applied in swaths, typically 90 – 150' wide depending on the aircraft used. Although the aircraft would not re-fly the same area, it could move back and forth in the same vicinity on several passes. Noise would be noticeable by people in residences, administrative sites, or recreating in or adjacent to a protection area. Most aircraft activity would occur in the morning, from just before first light until about mid-morning. There could be additional aircraft noise in the afternoon, when observation aircraft does reconnaissance of the next day's protection areas. Because of weather, timing, ore elevation, spray aircraft could be in the same vicinity for several days. Mitigation measures could help minimize the impact of aircraft noise. The path from the staging area to the protection area could avoid areas of potential noise disturbance. As with the potential for accidents, the size and location of protection areas in each alternative determines the extent of possible effects. Noise would not be an issue in the No Action Alternative since operations would not be conducted and equipment would not create noise.

In conclusion, the larger an operation, the higher the risk for accidents or spills. There are no guarantees that accidents or spills can be avoided, nor the effects from operations (such as noise or area closures) completely mitigated. However, the mitigation measures and procedures outlined above could minimize impacts and/or the likelihood of such events occurring.

NO ACTION ALTERNATIVE

Noise would not be an issue in the No Action Alternative since operations would not be conducted and equipment would not create noise.

The chance of accidents from extra vehicles would be reduced.

PROPOSED ACTION

Projects would be conducted on specific acres. There would be some opportunity for accidents and spills. Roads and campgrounds would be posted prior to treatment. There may be some short-term noise concerns, primarily over high-use and residential areas.

EXPANDED PROTECTION ALTERNATIVE

This alternative identifies a large number of acres to be protected. The opportunity for accidents, spills and noise concerns would increase because of increased numbers of people and equipment on the project.

TM-BIOCONTROL ONLY ALTERNATIVE

Effects would be the same as for the Proposed Action.

ISSUE 11: SECONDARY MORTALITY FROM BARK BEETLES

In general, bark beetles prefer stressed and weakened trees. When a disturbance, such as a fire or wind storm occurs, the beetles attack damaged trees and produce high numbers of offspring. Subsequent generations attack and kill healthy trees as the supply of stressed trees diminishes. Old-growth stands are highly susceptible to Douglas-fir bark beetle outbreaks because the large, slow-growing trees are often already under stress from competition with other trees and vegetation.

Mortality from bark beetles is correlated to defoliation but is influenced by environmental conditions proceeding and during the outbreak (Berryman and Wright, 1978; Wickman, 1979). In some cases, more mortality can be attributed to the beetles than to tussock moth. Douglas-fir suffers proportionally higher mortality than other host species because it suffers higher levels of defoliation and has a high secondary mortality rate from bark beetles. One study found that if a stand contained more than 50% Douglas-fir, the stand mortality more than doubled (Wickman, 1978). Douglas-fir bark beetles prefer large trees and therefore, almost all beetle mortality occurs in dominant and co-dominant trees. Mortality from other causes has been recorded as well: fir engraver, fir borers, dwarf mistletoe, and other unknown factors (Wickman, 1958; Beveridge, 1981). In general, stands which suffer the most significant mortality from bark beetles are those receiving moderate to heavy defoliation, with a stand composition of 50% or more Douglas-fir, and with a stand structure which consists primarily of dominant and co-dominant host trees.

Because of the "clumpiness" of a Douglas-fir tussock moth outbreak, most mortality usually occurs in patches rather than scattered throughout a stand. Patch size can vary from several hundred to several thousand acres. Where Douglas-fir beetle populations are already elevated (particularly on the Newport Ranger District, Colville NF, and on parts of the Wallowa-Whitman and Malheur NFs), significantly higher additional mortality from bark beetles in defoliated areas is expected

Treatment with either B.t.k. or TM-BioControl could prevent some secondary mortality. Since moth larvae are actively feeding at the time of treatment, not all defoliation would be prevented and some trees would become susceptible to secondary attack. Although protection would not prevent all mortality from these additional forces, less mortality would occur than without protection. Bark beetle populations would not increase in large numbers of susceptible trees and mortality in subsequent years would not be as significant.

NO ACTION ALTERNATIVE

Maximum defoliation and subsequent bark beetle mortality would occur. Additional mortality from bark beetles

would probably be 6 - 43%, depending on stand and environmental conditions. High-risk areas would experience the most mortality.

PROPOSED ACTION

Protected areas would experience less additional mortality than unprotected areas where additional mortality would be mostly in larger trees. Any trees defoliated prior to protection would still be susceptible to beetle attack; additional measures to protect these trees against Douglas-fir beetle mortality might be necessary.

All areas outside of the protection area would experience bark beetle mortality as described in the No Action Alternative. High risk sites would be at greatest risk.

EXPANDED PROTECTION ALTERNATIVE

This alternatives would protect more acres than other alternatives. Subsequent bark beetle mortality would be less.

All areas outside of the protection area would experience bark beetle mortality as described in the No Action Alternative. The greatest risk is on high-risk sites for defoliation.

TM-BIOCONTROL ONLY ALTERNATIVE

Effects would be the same as in the Proposed Action.

OTHER: AREAS OF CONCERN IN WILDERNESS

Regulations and policy allow for control of insects and disease in Wilderness IF:

- It is necessary to prevent unacceptable damage outside the Wilderness.
- It is to maintain or restore habitat for threatened, endangered, or sensitive species.
- It is to control an unnatural loss from exotic species.

Two Areas of Concern have been included in Wilderness for analysis in the Proposed Action:

- 1) *An area along a portion of the Wolf Creek drainage in the Lake Chelan-Sawtooth Wilderness (5,850 acres).* The effects of defoliation from the tussock moth could create an increase in fuels and subsequent risk of fire that would result in an unacceptable to the resources and property outside the Wilderness. Treatment of the moth to prevent such effects may not be possible without also treating that portion of the drainage in Wilderness. Treatment would only include the minimum needed to protect the above-identified values outside the Wilderness. In addition, treatment would only occur if the moth reaches sub-outbreak / outbreak levels. (Refer to the effects analysis in the "Fire" section, page IV-11.)
- 2) *An area in the North Fork Umatilla Wilderness in that river's watershed (5,890 acres).* This area contains Columbia River bull trout, a species listed as threatened by the US Fish & Wildlife Service. Defoliation by the tussock moth could result in a loss

of shade and an increase stream temperatures, which would result in important spawning and rearing habitat area being degraded. (Refer to the analysis found in the "Fish and Wildlife: Threatened & Endangered Species" section, page IV-15.) Defoliation in the upland areas of this watershed would increase fuels and risk of fire, which in turn would result in an unacceptable risk of increased and sedimentation into the river system. (Refer to the effects analysis in the "Fire" section.)

OTHER CONCERNS: EFFECTS ON ADJACENT LANDS (I.E. SPREAD OF MOTH POPULATIONS)

DFTM populations arise in-place. Limited dispersion can occur if very small caterpillars are blown in the wind. The fact that the female does not fly allows protection of specific areas without concern for reinvasion. Outbreaks occur because DFTM populations are already on site and conditions are favorable to population explosion. The "boom and bust" characteristic of DFTM outbreaks means the population does not resurge to outbreak level again after protection, much less spread to adjacent ownerships.

There is little danger for spread of DFTM from unprotected onto protected lands or from infected lands to uninfected adjacent lands, regardless of the number of acres protected.

OTHER CONCERNS: CUMULATIVE EFFECTS OF TREATMENT

PREVIOUS FOREST INSECT SUPPRESSION PROJECTS

Large-scale forest insect suppression projects have been conducted at various times throughout eastern Washington and Oregon for over 50 years, primarily for western spruce budworm, and in a couple instances, for Douglas-fir tussock moth. These projects occurred on all ownerships including National Forest, Indian Reservation, and State and private lands. Earlier projects from 1948 to 1974 used DDT (Graham, et. al., 1975; Dolph, 1980). Later projects conducted in 1975 to 1983 used chemical insecticides. The primary insecticides used were Malathion™ and carbaryl, although smaller experimental projects testing the effectiveness of insecticides such as fenitrothion, matacil, and acephate were also conducted in the mid-70s (Dolph, 1980; Sheehan, 1996a, Sheehan, 1996b). Since 1984, with the exception of some carbaryl use on private lands, B.t.k. has been used almost exclusively (Ragenovich, 1988; Sheehan, 1996a; Sheehan, 1996b). Projects varied in size from 80 acres treated for experimental use, to over 930,000 acres treated operationally in one year. The largest projects occurred in 1950 (933,300 acres) and 1951 (936,600). The most recent projects were in 1999 on the Yakima IR and adjacent State and private lands (45,000 acres).

Treatments on forest areas were often widely separated in space and time. Over this 50-year period, some areas have been treated only once and more often twice. A few areas have been treated up to four times. Western spruce budworm outbreaks often last for 7-13 years. Annual

suppression projects were conducted during the outbreak period, but the same areas generally were not treated more than once during that outbreak. Many of the areas treated in earlier outbreaks are not being considered in this analysis. This includes projects conducted in 1940-52, 1962, 1974, 1988-90, 1993, and 1999 on parts of the Willamette and Mt. Hood National Forests, and Warm Springs, Yakima, and Colville Indian Reservations, and State and private lands throughout eastern Washington and Oregon. Most treatments on State and private lands were done in conjunction with the larger treatment programs that included National Forest lands that same year.

The earlier treatments, primarily with DDT and chemical insecticides, were not monitored for effects on any insects other than the target insect, nor is it likely that any monitoring was done on other fauna. Certainly almost all of the insect fauna and most likely other fauna, such as birds and species that rely on insects for food, would have experienced effects from the treatments of this broad-spectrum insecticide. Any assumptions regarding these effects would be purely speculative.

There are some underlying guidelines regarding this analysis:

- Effects from any treatments 20 years ago would no longer be evident. Species either would have recovered to pre-treatment levels or other ecosystem/climatic would have influenced insect population changes in such a way that the treatment impacts would have been negated.
- If a species had been extirpated in previous projects, it remains extirpated.
- Monitoring of treatment effects on target species (i.e. western spruce budworm) for both carbaryl and B.t.k. indicates that lasting population suppression does not occur. Although this is an indication a populations ability to recover, it cannot be assumed that other species would respond in the same way.
- A number of recent studies on non-target Lepidoptera show that these insects return to pre-treatment levels – both in species richness and population numbers in 2-3 years. This recovery is likely due to a resurgence of populations in place and movement of populations from untreated into treated areas. A conservative estimate of 5 years has been used in this analysis.
- Percentages of acres previously treated and those that are currently being analyzed are estimates of relationships.
- TM-BioControl would not result in any effects to other insects. B.t.k. would have effects on other Lepidoptera.

The following discusses the approximate locations of treatments in previous years and the approximate percent of those areas included in the current analysis.

COLVILLE NATIONAL FOREST

No areas on the Colville NF have been treated previously. No cumulative effects from previous treatments could be expected under any action alternative.

OKANOGAN NATIONAL FOREST

No areas on the east side of the Okanogan Forest have been previously treated. No cumulative effects from previous treatments could be expected under any action alternative.

On the west side of the Okanogan Forest, some areas were treated for western spruce budworm in 1976 and 1977. About 50% of the area treated in 1976 was retreated in 1977, along with additional acres. Malathion™ was used in 1976, and carbaryl (Sevin-4-Oil™) was used in 1977. There have been no insect suppression projects on the Okanogan in the last 22 years.

The Proposed Action and the TM-BioControl Only Alternative analyze potential effects on specific Areas of Concern. Approximately 70% of the areas currently proposed for protection were treated in 1976 - 1977. The remaining 30% have never been treated.

The Expanded Protection Alternative includes lands proposed for protection in the Proposed Action plus all other areas with 60-100% host type. Most of the area treated in 1976/77 is included in this alternative.

There are no cumulative effects from previous and proposed treatments.

WENATCHEE NATIONAL FOREST

Previous projects on the Wenatchee NF included one small project in 1951 using DDT. The treatment area was located just west of Leavenworth. Areas between Cle Elum and Leavenworth were treated in 1976 and 1977 with Malathion™ and carbaryl. In 1987, an area around Rimrock Lake was treated with B.t.k. to control western spruce budworm.

About 80% of the area in the Proposed Action has been previously treated. None of 1951 acres are included in the current analysis. Almost all of the current analysis area was treated in 1976 and/or 1977. These are the areas north of Leavenworth and between Cle Elum and Leavenworth. The Proposed Action could retreat approximately 30% of the area treated in 1976/1977. There would be no cumulative effects from these previous treatments because of the treatment interval (22 years minimum).

The area treated in 1987 had not been previously treated. It includes a cluster of Areas of Concern in the most southern part of the Forest. The current Proposed Action could retreat approximately 40% of the 1987 treatment area. There would be no cumulative effects to non-target Lepidoptera if all or part of this area is retreated.

Treatments with DDT in 1962 and B.t.k. in 1990 occurred on the south part of the Yakima Indian Reservation. The most recent western spruce budworm treatments on State, private, and tribal lands (1996-1999) are 20-50 miles from the area analyzed in this EIS. It is expected that there

would not be cumulative effects to non-target Lepidoptera because of the distances between treatment areas.

UMATILLA NATIONAL FOREST

Almost all of the Umatilla Forest was treated with DDT for western spruce budworm between 1951 and 1953. Almost all of the Forest south of Heppner and east of Ukiah was retreated in 1982/1983 with carbaryl. In addition, portions of the Forest south and north of Ukiah were treated. Areas of Concern identified in this analysis comprise just 5% of the area treated in 1982/1983. Since the Expanded Protection Alternative includes most host type, this alternative could retreat 75% of the 1982/1983 area. Most of the southern half of the Umatilla Forest has not been treated since 1983.

In addition to treatments in the 1950s, portions of the north half of the Umatilla were treated with DDT in 1974 to control Douglas-fir tussock moth. Scattered areas southeast, east, and northeast of Pendleton were retreated 1988 and 1992 with B.t.k. for western spruce budworm. About half of the 1988 area (southeast of Pendleton) was retreated in 1992. Using the 5-year recovery assumption, there could have been adverse cumulative effects on non-target Lepidoptera in those areas treated in 1988 and again in 1992. The Proposed Action could retreat 5 % of the 1988 or 1992 area. The Expanded Protection Alternative could retreat 80% of those areas.

About half of that portion of the Umatilla Forest that lies in southeast Washington was treated in the early 1950s with DDT. A small portion on the eastern edge of the Forest was retreated in 1974 for Douglas-fir tussock moth. A small area, northeast of Walla Walla, was treated with B.t.k. in 1992. Some Areas of Concern included in the Proposed Action are in this area. Approximately 50% of the area in the Expanded Protection Alternative was included in the 1950s treatment.

The most recent treatments on the Umatilla Forest were with B.t.k. 8 years ago. Therefore, there would be no cumulative effects on non-target Lepidoptera.

WALLOWA-WHITMAN NATIONAL FOREST

Nearly all Areas of Concern in this analysis have been previously treated on the Wallowa-Whitman Forest during the last 50 years. Some portions on the southern half (south of La Grande and west of Baker City) were treated in 1950, 1954, 1955, or 1958 with DDT for western spruce budworm. None of these areas was treated more than once during that time. None of this part of the Forest has been retreated.

Parts of the Forest, northeast of Baker City and east of LaGrande, were also treated in the early 1950s with DDT for western spruce budworm. Some of this area was retreated for Douglas-fir tussock moth in 1974, and again in 1991 with B.t.k. Additional areas were treated in 1992 with B.t.k. for western spruce budworm. Areas treated in 1991 were not retreated in 1992. Some areas south of the

Eagle Cap Wilderness were treated in the 1950s, in 1974, and in 1991.

Under the Proposed Action, 90% of the 1991 area and 5% of the 1992 area could be retreated. Under the Expanded Protection Alternative, retreatment could occur on 85% of those areas. Some other areas in the Expanded Protection Alternative, specifically those northeast and northwest of the Eagle Cap Wilderness, and north of Enterprise, have only been treated once, in 1974 or in 1992.

The most recent treatments on the Wallowa-Whitman Forest were 8 years ago with B.t.k. Due to the treatment interval (not less than 8 years), there would be no cumulative effects on non-target Lepidoptera.

MALHEUR NATIONAL FOREST

Extensive portions of the Malheur NF were treated with DDT in 1955 or in 1958. Portions of the Forest were treated again, primarily with carbaryl, in 1982 and 1983. More areas were treated with B.t.k. in 1985 and 1987. About 10% of the area treated in 1982/1983 was retreated in the 1985 and 1987 projects. The area treated in 1985 is southwest of John Day. Areas of Concern in the Proposed Action comprise about 15% of the 1985 areas. The Expanded Protection Alternative could retreat an additional 20% of the 1985 area.

The 1987 treatment area is mostly north of John Day with some scattered areas throughout the Forest south of John Day. The Proposed Action could retreat areas southeast of John Day and south of the Strawberry Wilderness that were treated in the 1950s. In addition, small Areas of Concern north of John Day were treated in 1987. The Expanded Protection Alternative could retreat approximately 75% of the 1987 treatment area. Areas of Concern northeast, east, and southeast of John Day were not included in the 1987 treatment, but many were included in the 1982/1983 treatments.

In summary, most areas proposed for protection have been previously treated. However, no adverse cumulative effects to insects are expected because of treatment interval length (12 years minimum).

OCHOCO NATIONAL FOREST

The northern part of the Ochoco National Forest was treated with DDT in 1955. Approximately 80% of Areas of Concern in this analysis were treated in 1955; however, the new protection areas comprise 40% of the 1955 treatment zone. Since the most recent treatment occurred 45 years ago, there would be no cumulative effects.

WINEMA NATIONAL FOREST

No areas on the Forest have been treated previously. There would be no cumulative effects.

FREMONT NATIONAL FOREST

No areas on the Forest have been treated previously. There would be no cumulative effects.

OTHER FOREST USES

In addition to these projects, various smaller projects have been conducted. These projects included activities such as control insects in high value seed orchards. These treatments were occasional and limited in size, and would not result in cumulative effects.

ACTIVITIES OUTSIDE NATIONAL FORESTS

In addition to the insect suppression activities on the National Forests, insect suppression activities on adjacent lands could affect insect, and specifically, Lepidoptera. Private land owners may decide to take action to control Douglas-fir tussock moth outbreaks on their lands. Since TM-BioControl is not available to them, they would have to use a currently registered insecticide, such as B.t.k., tebufenozide, diflurbenzuron, or carbaryl. B.t.k. and tebufenozide would affect other Lepidoptera; diflurbenzuron and carbaryl would also affect other insects.

Many of the areas adjacent to or near National Forest lands are agricultural. These agricultural uses include a variety of vegetable products, grain crops and corn, and fruit orchards. People living in the vicinity may have gardens, lawns, and trees. Insecticides of various kinds will be used, either in limited quantities (as in the case of homeowners) or more extensively (as in the case of agricultural products). Individual uses could accumulate into a significant amount and may have an impact on overall insect populations. Large insect suppression projects for grasshoppers on rangeland have occurred in the past and may have occurred on or adjacent to National Forest lands.

In addition, native insects most likely have been affected by removal of their host plants or conversion of their habitats. Conversion of habitat would include such things as expansions of residential areas into previous habitats such as meadows, conversion to agricultural uses, or invasive weeds, displacing their native host plants.

Summary of Cumulative Effects

In the past 50 years, insect suppression projects have occurred on many areas being considered in this analysis. Treatments have often been greatly separated by distance and time. The most extensive projects were conducted in the 1950s when DDT was used to treat western spruce budworm. Later projects in the mid-70s to early 80s used insecticides such as carbaryl, Malathion™, and acephate. The most recent projects, from the mid 1980s to 1993, used B.t.k. Most of the Areas of Concern being analyzed have been treated at least once before; some have been treated more than twice. In a few cases, areas have been treated 3-4 times. It is estimated that about 90 Areas of Concern identified in this analysis have been treated at least once in the past 50 years.

Treatments occurring more than 20 years ago would not likely be evident. Lepidoptera species either would have recovered to pre-treatment levels or ecosystem changes would have influenced insect population changes

in such a way that treatment impacts would have been negated. In addition, it is likely that Lepidoptera populations that were affected by previous treatment would recover in 5 years.

The Colville, Winema, and Fremont Forests have never been treated in large-scale forest insect suppression projects, so areas considered in this analysis would not be subjected to cumulative effects from previous projects. Areas on the Okanogan, Wenatchee, and Ochoco Forests have only been treated once. Areas on the Ochoco were treated in the early 1950s; areas on the Okanogan were treated in 1976-77. Most Areas of Concern on the Wenatchee NF were treated once, in 1976-77. One area near Rimrock Lake was treated in 1987. Most of the suppression project activity occurred on the Umatilla, Malheur, and Wallowa-Whitman NF's. A large portion of both of these Forests was treated in the early 1950s. Much of this same area on the Malheur and Umatilla Forests were treated again 30 years later (in the early 1980s) with carbaryl. Additional projects using B.t.k. were conducted on in the late 80s and early 90s. The last treatment conducted on any of the areas in this analysis was in 1993.

Because of the time between treatments, it is estimated that cumulative impacts from the current project on other insects would be minimal. In addition, many native insects have been affected by removal of their host plants or conversion of their habitats (expansion of residential areas into meadows, conversion to agricultural uses, invasive weeds displacement, etc.).

NO ACTION ALTERNATIVE

There would be no cumulative effects from the No Action Alternative.

PROPOSED ACTION

Depending on location and proximity of private lands and frequency of other insecticides used, there could be some localized cumulative effects, mostly on non-federal lands. Overall, there would be no cumulative effects on National Forest lands.

EXPANDED PROTECTION ALTERNATIVE

Depending on location and proximity of private lands and frequency of other insecticides used, there could be some localized cumulative effects, mostly on non-federal lands. The larger area and additional use of B.t.k. increases possibility of overall cumulative effects.

TM-BIOCONTROL ONLY ALTERNATIVE

No cumulative effects are anticipated from this alternative.

OTHER CONCERNS: BENEFITS AND COST OF OPERATIONS

The benefits of this operation are the resources protected in the various alternatives. A summary of those benefits can be found in Chapter II, Comparison of Alternatives table.

The cost of a Douglas-fir tussock moth spray project would include the cost of the operational aircraft, insecticide and/or mixture components, support equipment,

insect and environmental monitoring crews, and administrative costs. Costs vary by contractor bid, cost of materials, and logistics of implementation. It is estimated that the cost of this project would be similar to previous western spruce budworm projects. Although the Forest Service owns TM-BioControl, the cost of the molasses and sunscreen, additional handling and mixing, and higher volume per acre application rate, or the purchase of 038 carrier, would probably make the actual cost per acre for both insecticides similar. It is estimated that the total cost of a Douglas-fir tussock moth protection effort would be \$15 - \$25 per acre.

NO ACTION ALTERNATIVE

No operational costs would be incurred.

PROPOSED ACTION

Most of the protection areas would probably be irregularly shaped or small, requiring more flight time and movement of equipment in relation to the number of acres protected. In addition, since commercial insecticide is produced in bulk, smaller quantities could be more expensive than

purchased in bulk. It is expected that the cost per acre for this alternative would be less than the Proposed Action.

Estimated Cost = \$10.5 - \$17.5 million for treatment on 700,000 acres; worst-case: \$37.7 - \$62.9 million.

TM-BIOCONTROL ONLY ALTERNATIVE

Estimated Cost = \$4.5 - 7.5 million for treatment on 300,000 acres.



larger ones. These factors could increase the overall cost of the project.

Estimated Cost = \$4.5 - 7.5 million for treatment on 300,000 acres; worst-case: \$8.4 - 14.0 million.

EXPANDED PROTECTION ALTERNATIVE

Many of the protection areas would be large, lending themselves to easier application. Less time would be spent flying and in moving equipment around in relation to the number of acres protected. More material could be

SPECIFICALLY REQUIRED DISCLOSURES

CLIMATE

Global changes have been a concern in the last decade. Evaluation of global climate change in a small project level document would be speculative and is beyond the scope of this project. Research is being conducted on a broader scale, which includes the implications of Forest management activities. This document is not an appropriate way to address the global change issue.

PRIME FARMLAND, RANGELAND, AND FORESTLAND

The areas being considered for protection under this document do not contain prime farmlands or range lands. "Prime" forestland is a term used only for non-federal land and does not apply to lands in the National Forest System.

MINORITY GROUPS, WOMEN, AND CIVIL RIGHTS

All action alternatives propose a strategy for dealing with an expected tussock moth outbreak in eastern Washington and Oregon. With this strategy, several thousand acres of National Forest land would be protected with insecticide(s). It is anticipated that none of these alternatives would have a direct effect on minority groups, women, or civil rights.

The indirect effect of these alternatives could be an opportunity for employment. The Expanded Protection Alternative would provide the greatest opportunity for employment since more acres could be protected. Employment could include insecticide application, supply of materials, and other business support functions. With the No Action Alternative, there would be no opportunity for project-related employment.

UNUSUAL ENERGY REQUIREMENTS

Implementing action alternatives would require consumption of fossil fuels by aircraft and ground-based support vehicles. Except for the conservative use of operational vehicles, no major opportunities for energy conservation were identified.

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

An irreversible commitment of resources results from a decision to use or modify resources that is renewable only over a long period. No irreversible commitment of resources has been identified.

An irretrievable commitment of resources would occur when opportunities are foregone for the period that the

resource could not be used. No irretrievable commitment of resources has been identified.

WETLANDS AND FLOODPLAINS

Wetlands and floodplains would be affected by all alternatives. The No Action Alternative would not protect any riparian areas along any wetlands and flood plains. Under the Proposed Action and TM-BioControl Only Alternative, Areas of Concern along wetlands and floodplains would be protected to prevent defoliation. Riparian areas along other wetlands and floodplains would not be protected and defoliation could occur. The Expanded Protection Alternative would protect riparian areas along all wetlands and floodplains. The specific effects of each alternative on wetlands, floodplains, and dependent wildlife is discussed in detail in this analysis.

POTENTIAL CONFLICTS WITH PLANS AND POLICIES OF OTHER JURISDICTIONS

There are no conflicts expected between the action alternatives and the plans and policies of other agencies.

ENVIRONMENTAL JUSTICE

On February 11, 1994, President Clinton signed Executive Order 12898. This order directs each federal agency to make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations. The President also signed a memorandum on the same day, emphasizing the need to consider these types of effects during NEPA analysis.

On March 24, 1995, the Department of Agriculture completed an implementation strategy for the executive order. Where Forest Service proposals have the potential to disproportionately adversely affect minority or low-income populations, these effects must be considered and disclosed (and mitigated to the degree possible) through the NEPA analysis and documentation.

Effects of alternatives on the human environment (including minority and low-income populations) are disclosed in the Effects on Human Environment section. Effects are expected to be similar for all human populations, regardless of nationality, gender, race, or income.

CHAPTER V: LIST OF AGENCIES, ORGANIZATIONS, AND PERSONS

INTRODUCTION

As part of the scoping process, Forests mailed a questionnaire to people on their respective mailing lists. On this form, respondents were asked to answer four questions. At the bottom of this form, respondents were asked to indicate if they 1) wanted to be on the EIS mailing list, 2) if they wanted a copy of the full EIS, and 3) if they did not want a full copy of the EIS, did they want a copy of a summary. The majority of respondents indicated they preferred a summary rather than the complete document. Additionally, a few respondents indicated they did not want to be on the project mailing list. The names of the people not wanting on the mailing list do not appear in the lists below.

The following lists identify the agencies, organizations and persons to whom full copies or summaries of the DEIS were sent and to whom the Final EIS will be sent. For a full discussion of the public involvement process, please refer to Appendix C.

FEDERAL AGENCIES AND DEPARTMENTS

Advisory Council on Historic Preservation

- Western Office of Review

U.S. Department of Agriculture

- USDA, OPA Publications Stockroom
- Animal & Plant Health Inspection Service
- Office of Equal Opportunity (OEO)

US Department of Interior

- Crater Lake National Park, Crater Lake, OR
- US Fish & Wildlife Service, Little Pend Oreille National Wildlife Refuge, Colville, WA
- US Fish and Wildlife Service, North Pacific Coast Ecoregion, Lacey, WA

US. Department of Commerce

- Director, Ecology and Conservation Office
- National Marine Fisheries Service (Portland, Oregon)

US. Department of Defense

- North Pacific Unit, COE division (Portland, Oregon)

US. Department of Energy

- Director, Office of Environmental Compliance

US Environmental Protection Agency

- Regional Office, Region 10 (Seattle, Washington)

Federal Aviation Administration

- Northwest Regional Office, Renton, Washington

Federal Energy Regulatory Commission

- Advisor on Environmental Quality

Federal Highway Administration

- Regional Administrator, Region 10 (Portland, Oregon)

Federal Railroad Administration

- Office of Transportation and Regulatory Affairs

General Services Administration (GSA)

- Office of Planning and Analysis

US Department of Housing and Urban Development (Seattle, Washington)

US Department of Housing and Urban Development (Portland, Oregon)

US Department Of Interior

- Director, Office of Environmental Policy and Compliance

Surface Transportation Board

- Chief, Energy and Environment

Northwest Power Planning Council (Portland, Oregon)

Pacific Northwest Region – USDA Forest Service

- Environmental Coordinator

NATIVE AMERICAN CONTACTS

The Klamath Tribe

Confederated Tribes of the Warm Springs

Confederated Tribes of the Colville

Confederated Tribes and Bands of the Yakima

Kalispell Indian Community

Nez Pierce Tribe

Confederated Tribes of the Umatilla

The Spokane Tribe

Burns Paiute Tribe

OREGON NATURAL RESOURCE AGENCIES

Department of Fish and Wildlife

Water Resources Department

Department of Land Conservation and Development

State Economist

Governor's Forest Advisor

Parks and Recreation Department

Department of Environmental Quality

Rural Development Section

Forestry Department

RESPONDANTS

Government Agencies, Businesses, Organizations, and Citizens who responded during the public comment period:

49 North Ski Area, Chewelah, WA
Alliance for the Wild Rockies, Missoula, MT
Blue Mountain Biodiversity Project, Fossil, OR
Blue Mountain Lumber Products, Pendleton, OR
Bureau of Land Management (BLM), John Day, OR
Superintendent, Crater Lake Nat'l Park, Crater Lake, OR
City Recorder/Manager, Canyon City, OR
Eastern Oregon Sportsman Assoc., John Day, OR
Evergreen Helicopters, Mcminnville, OR
Forest Resource Services, Salem, OR
Glide Lumber Co./Western Timber Co., Glide, OR
Grant County Conservationists, John Day, OR
Grant County Court, Canyon City, OR
Haglund, Kirtley, Kelly, and Horngren, Portland, OR
Hells Canyon Preservation Council, La Grande, OR
Heppner Chamber of Commerce, Heppner, OR
Kettle Range Conservation Council, Republic, WA
KPLV, Environmental Beat, Seattle, WA
Kralman Steel Structures, Milton Freewater, OR
Little Pend Oreille National Wildlife Refuge, Colville, WA
Longview Fiber Company, Longview, WA
Malheur Lumber Company, John Day, OR
Malheur Timber Operators Inc., John Day, OR
Methow Valley Snowmobile Assoc., Winthrop, WA
Natural Resources Research Library, Logan, UT
NW Coalition for Alternatives to Pesticides, Eugene, OR
Northwest Forestry Assoc., Portland, OR
Ochoco West Water District, Prineville, OR
Okanogan County Snowmobile Club, Brewster, WA
Oregon Natural Res. Council, Eugene and Portland, OR
Oregon Heirs Corp., Sylmar, CA
Oregon Public Lands Action Committee, Lakeview, OR
Prairie Wood Products, Prairie City, OR
Mayor, City of Republic, Republic, WA
Roseboro Lumber Co., Bend, OR
Sussee's Skyline Packers Inc., Tacoma, WA

US Fish & Wildlife Service, North Pac. Coast Ecoregion, Lacey, WA

V.P. Harney County High Desert Fur Takers, Burns, OR
Vaagen Brothers Lumber Co., Colville, WA
State Parks and Recreation Commission, Olympia, WA
Washington State Snow Mobile Assoc., Dayton, WA
Wallowa County Commissioner, Enterprise, OR
Wilderness Watch, Missoula, MT

Ahman J., Drewsey, OR
Barke C., Seattle, WA
Bigas P., Seattle, WA
Bowker L., Eureka, Ca
Brazeal J., Lakeview, OR
Burrows R., Kent, WA
Cameron D., Prineville, OR
Cannon R., Mitchell, OR
Cason J., Prineville, OR
Cheatham A., Union, OR
Chicken C., Walla Walla, WA
Copeland M., Anchorage, AK
Cook S., Eugene, OR
Crampton S., Twisp, WA
Cromwell B., Republic, WA
Culbertson G., Springfield, OR
Curtis R., Burns, OR
Donaca D., Prineville, OR
Dovenberg J., Sherwood, OR
KPLV, Environmental Beat, Seattle, WA
Erwin A., Ashland, OR
Ferm P., Monroe, WA
Finlayson S., Burns, OR
Fisher E., Eugene, OR
Foecke, D., Leavenworth, WA
Gabrielsen S., Hayden Lake, ID
Gebhardt C., Seattle, WA
Geisler D., Burns, OR
Gilbert B., Heppner, OR
Givler L., Vashon, WA
Glerup R., Hines, OR

Goodwin R., Eugene, OR
 Gritman F., Dayton, WA
 Harris E., Canyon City, OR
 Herbst J., La Grande, OR
 Higgins M., Halfway, OR
 Hines J., Ventura, CA
 Holmes S., Kimberly, OR
 Humbert S., Milton Freewater, OR
 Kazda G., Portland, OR
 Kazda E., Portland, OR
 Kazda J., Portland, OR
 Kennedy R., Lakeview, OR
 Kile L., Wenatchee, WA
 Kinsel B., Seattle, WA
 Klinger D., Leavenworth, WA
 Kominski R., Leavenworth, WA
 Kupillas E., Eagle Point, OR
 Langdon J., Coeur D Alene, ID
 Lee B., Wenatchee, WA
 Lenox S., Lebanon, OR
 Loe P., Seattle, WA
 Looney B., Bend, OR
 Loper B., Grants Pass, OR
 Mallon M., Ardenvoir, WA
 Marsh N., Salem, OR
 Mason R., Corvallis, OR
 Mcmillan B., Baker City, OR
 Morrow A., Madras, OR
 Mullin S., Prairie City, OR
 Needles E., Sumpter, OR
 Nelson D., Priest River, ID
 Ostertag G., Keizer, OR
 Paul S., Yakima, WA
 Pedracini D., Sumpter, OR
 Perkins E., Prineville, OR
 Phillips D., Baker, OR
 Pitz C., Olympia, WA
 Porter D., Milwaukee, OR
 Prowell D., Baker City, OR

Ritter J., Salem, OR
 Rose R., Pasco, WA
 Roufs R., Paulina, OR
 Rourke M., Republic, WA
 Sanowski B., Paulina, OR
 Scott D., Ontario, OR
 Scott P., Naches, WA
 Secord D., Prairie City, OR
 Seely L., Manzanita, OR
 Smerski D., Burns, OR
 Spitz J., Bend, OR
 Still L., Canyon City, OR
 Swatek S., Portland, OR
 Taylor D., Hermiston, OR
 Thomason M., Moses Lake, WA
 Town S., Vale, OR
 Vandehey R., Fossil, OR
 Voigt P., Prairie City, OR
 Watson G., Lewiston, ID
 Weitman T., Tualatin, OR
 Wenzler/Gilchrist, Winthrop, WA
 Westerlund G., Kent, WA
 Wiggins R., Joseph, OR
 Williams J., Bend, OR
 Williamson M., Colville, WA
 Wilson L., Corvallis, OR
 Yockim R., Roseburg, OR
 Zita R., Pendleton, OR

The following table represents those that submitted comments on the draft EIS.

CATEGORY	NAME	CITY, STATE
Agency	County Court for Harney County	Burns, OR
Agency	State of Oregon, Department of Forestry	Salem, OR
Agency	State of Washington, Department of Health	Olympia, WA
Agency	State of Washington, Department of Natural Resources	Olympia, WA
Agency	US Environmental Protection Agency	Seattle, WA
Agency	US Fish & Wildlife Service, North Pacific Coast Ecoregion	Western Washington Office; Lacey, WA
Agency	Wallowa County Bd. of Commissioners	Enterprise, OR
Citizen	Arnie Arneson Cascade Woodlands	Wenatchee, WA
Citizen	Denise Bevacqua	Seattle, WA
Citizen	Susan Crampton	Twisp, WA
Citizen	Rodney L. Crawford Burke Museum	Seattle, WA
Citizen	Claire Hagen Dole Butterfly Gardeners' Quarterly	Seattle, WA
Citizen	Bruce Dunn RY Timber, Inc.	Joseph, OR
Citizen	C. Dean Finch	Caldwell, ID
Citizen	Jack Harper	Washougal, WA
Citizen	Helen Jones	Prineville, OR
Citizen	David M. Klinger	Leavenworth, WA
Citizen	David V. McCorkle, Ph.D.	Monmouth, OR
Citizen	Donald E. Miller	Enterprise, OR
Citizen	Ron Mitchell	Boise, ID
Citizen	George & Rhonda Ostertag	Keizer, OR
Citizen	Steve Paul	Yakima, WA
Citizen	Cheryl Petterson	Seattle, WA
Citizen	Lisa Philipps	Salida, CO
Citizen	Robert Michael Pyle	Gray's River, WA
Citizen	James R. Reed	Klickitat, WA
Citizen	Jeff Ritter	Salem, OR
Citizen	Ron Rommel	
Citizen	Howard Rotstein	Portland, OR
Citizen	Hubert B. Sager Vaagen Bros. Lumber, Inc	Colville, WA
Citizen	Jon H. Shepard Lepidoptera Biodiversity	Nelson, BC Canada
Citizen	John K. Spence	Battle Ground, WA
Citizen	S. Duane Town	Vale, OR
Citizen	Dean & Mary Warner	Portland, OR
Citizen	Gary Westerlund	Kent, WA
Citizen	Boyd Wickman	Bend, OR
Citizen	Maurice Williamson, ACF Consulting Forstry	Colville, WA
Citizen	Rich Zita	Pendleton, OR
Organization	Alliance for the Wild Rockies	Missoula, MT
Organization	Big Bend Economic Dev. Council	Moses Lake, WA
Organization	Hells Canyon Preservation Council	LaGrande, OR
Organization	Kettle Range Conservation Group	Republic, WA
Organization	Keystone Project	John Day, OR

CATEGORY	NAME	CITY, STATE
Organization	The Lands Council, also representing: National Forest Protection Alliance Forest Conservation Council Blue Mtn Native Forest Alliance Colorado Wild OR Natural Resources Council Tonia Wolf	Spokane, WA Missoula, MT Santa Fe, NM Baker City, OR Boulder, CO Bend, OR Bend, OR
Organization	League of Wilderness Defenders Blue Mtns Biodiversity Project, also representing: Blue Mtn Native Forest Alliance OR Natural Resources Council The Lands Council	Fossil, OR Baker City, OR Bend, OR Spokane, WA
Organization	Malheur Timber Operators, Inc.	John Day, OR
Organization	Northwest Ecosystem Alliance	Chelan, WA
Organization	Xerces Society	Portland, OR

LIST OF PREPARERS

The following is a list of Interdisciplinary Team (IDT) members and those who assisted the IDT in the development of the Douglas fir Tussock Moth Environmental Impact Statement.

NAME	AREA OF EXPERTISE	EDUCATION	YEARS OF EXPERIENCE
Interdisciplinary Team Members:			
Bill Funk	ID Team Leader	B.S. Forest Management M.F. Forest Economics	33
Iral Ragenovich	Entomology	B.A. Biology B.S. Forestry M.F. Forest Entomology	25
Connie Mehmel	Ecology, Silviculture	B.S. Resource Management	22
Nick Reyna	Decision Support	B.S. Forest Management M.S. Forest Policy	20
Don Davison	Writer / Editor (Draft EIS)	A.S. Forest Technology	29
Melanie Fullman	Writer / Editor (Final EIS)	B.S. Forestry	15
Judy Wing	Public Affairs	B.S. Forest Recreation	11
Sharon Phillips	Wildlife Biology	B.S. Fisheries & Wildlife	7
Geographic Information Systems Specialists			
Julie Johnson	GIS Analysis	B.S. Forest Management	15
John Nelson	GIS Computer Support	B.S. Computer Info Systems / Math / Business	13
Tuyen Ta	GIS Technical Info. Computer Support	A.A. Information Systems	9
Paul Zellmer	GIS Computer Analysis	B.S. Fisheries	35
Patty Johnson	GIS	Not available	
Specialists who assisted the Interdisciplinary Team			
Dave Bridgwater	Entomology	B.S. Forestry M.F. Forest Entomology	29
Bruce McCammon	Hydrology	B.S. Watershed Science M.S. Hydrology	28
Pam Ensley	Fire/Fuels (Draft EIS)	Not available	

NAME	AREA OF EXPERTISE	EDUCATION	YEARS OF EXPERIENCE
Peter Teensma	Fire Ecology (Final EIS)	B.A. Geography PhD. Geography (Biogeography)	19
Terry Slider	Recreation Planning	B.S. Landscape Architecture	23
Phil Mattson	National Environmental Policy Act (NEPA)	B.S. Forest Watershed Mgt	25
Dick Carkin	NEPA	B.S. Forest Production M.S. Forest Management	32
Roger Ogden	NEPA	Not available	
Katherine Sheehan	Insects & Disease WEB Site	B.S. Cons. of Natural Resources Ph.D. Entomological Sciences	17
Grant Gunderson	T, E & S Wildlife Biology	B.S. Conservation Biology	27
Scott Woltering	T&E Fish Biology	B.S. Fishery Science	20
Rex Holloway	Public Affairs	B.S. Forestry	22
Tommy Gregg	Statistics	B.S. Biology	39
Bob Wooley	Botany	B.S. Botany M.S. Entomology M.F. Forest Ecology	20
Kent Woodruff	Wildlife Biology	B.S. Wildlife Biology	25
Ed Stocks	Editor Forest Coordinator	B.S. Forestry	30
Marti Ames	Public Affairs	Not available	25

GLOSSARY OF ACRONYMS AND TERMS

A

ACRE DOSE: The weight of a product (such as a virus preparation) required in treating one acre of forest.

ADFLUVIAL: In relation to fish species, migrating between lakes and rivers or streams.

ADVERSE: Any action which is antagonistic or opposite to the preferred action.

ALTERNATIVE: One of several policies, plans, or projects proposed for decision-making.

AMENITY: An object, feature, quality, or experience that gives pleasure or is pleasing to the mind or senses. Amenity value is typically used in land use planning to describe those resource properties for which market values (or proxy values) are not or cannot be established.

ANADROMOUS FISH: Those species of fish, spawned in fresh water, which mature in the sea, and migrate back into fresh water streams to spawn. Salmon, steelhead, and shad are examples.

AQUATIC ECOSYSTEMS: Stream channels, lakes, marshes, ponds, etc. and the plant and animal communities they support.

AQUATIC HABITAT: Habitat directly related to water.

B

Bacillus thuringiensis var. kurstaki (B.t.k.): Scientific name of the active ingredient of a bacterial insecticide, which is a formulation of spores and unique crystalline bodies, produced by the bacterium. The active ingredient in biological insecticides sold under such names as Dipel®, Bactospeine®, and Thuricide®. It acts as a stomach poison to leaf eating Lepidopteran insects (moths and butterflies) as the crystal dissolves, and parallaxes the gut wall, causing the larvae to stop feeding.

BACKGROUND: The visible terrain beyond the foreground and middle ground where individual trees are not visible but are blended into the total fabric of the forest stand (see foreground and middle ground).

BENEFIT: The results of a proposed activity, program, or project expressed in monetary or non-monetary terms.

BIOLOGICAL DIVERSITY: Refers to the number of different species in the community (Kimmins 1987)

BIOPHYSICAL: The combination of biological (plants and animals) and physical (rainfall, topography) components in an ecosystem.

BOREAL: Pertaining to the northern zone of plant and animal life lying just below the tundra and usually characterized by coniferous forests. Can also refer to higher elevations near the tree line.

B.t.k.: See *Bacillus thuringiensis* var. *kurstaki*

C

CANOPY: The uppermost spreading, branch layer of a forest.

CANOPY CLOSURE: The progressive reduction of space between tree crowns as they spread laterally; a measure of potential open space occupied by the collective tree crowns in a stand.

CARBARYL: Carbamate insecticide; the active ingredient in insecticide formulations sold under the trade name Sevin®. Carbaryl expresses contact and stomach poison action on target insects and shows relatively long residual effects.

CARCINOGENICITY: Tendency of a substance to cause cancer.

CANOPY CLOSURE: The progressive reduction of space between tree crowns as they spread laterally; a measure of the percent of potential open space occupied by the collective tree crowns in a stand.

CEQ: Council on Environmental Quality.

CHRONIC HEALTH EFFECTS: Health effects that may take repeated exposures over a period of months or years before becoming apparent. Chronic health effects may blend into the general health problems of life and never be detected.

CLIMAX: Species that are self-perpetuating in the absence of a major disturbance such as fire.

CHRONIC TOXICITY: The effect of a compound on test animals when exposed to sub-lethal amounts continually. Usually, daily exposures over a period of time: weeks, months, or years.

CODE OF FEDERAL REGULATIONS (CFR...): The listing of various regulations pertaining to management and administration of the National Forests.

CONCERN: A point matter, or question raised by management or public participants that must be addressed in the planning process.

CONNECTED ACTION: Actions, which are closely related, and which: 1) Automatically trigger other actions; 2) Cannot or will not proceed unless other actions are

taken previously or simultaneously; 3) Are independent parts of a larger action and depend on the larger action for their justification.

CRITICAL HABITAT: For threatened or endangered species, the specific areas within the geographical area occupied by the species (at the time it is listed, in accordance with provisions of Section 4 of the Endangered Species Act) on which are found those physical or biological features essential to the conservation of the species. This habitat may require special management considerations or protection. Protection may also be required for additional habitat areas outside the geographical area occupied by the species at the time it is listed, based upon a determination of the Secretary of the Interior that such areas are essential for the conservation of the species.

CROWN CLASSES:

1) **Dominant** - Trees with crown extending above the general level of the crown cover and receiving full light from above and partly from the side; larger than the average trees in the stand, and with crowns well developed but possibly somewhat crowded on the sides.

2) **Co-dominant** - Trees with crowns forming the general level of the crown cover and receiving full light from above but comparatively little from the sides; usually with small crowns considerably crowded on the sides.

3) **Intermediate** - Trees shorter than those in the two preceding classes but with crowns extending into the crown cover formed by co-dominant and dominant trees; receiving little direct sunlight from above but none from the sides; usually with small crowns considerably crowded on the sides.

4) **Suppressed (Over-Topped)** - Trees with crowns entirely below the general level of the crown cover, receiving no direct light either from above or from the sides.

CUMULATIVE EFFECTS: The combined effects of two or more management activities. The effects may be related to the number of individual activities, or to the number of repeated activities on the same piece of ground. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

D

DEFOLIATION: A process in which all leaves are removed from a tree. In this instance, eaten by the tussock moth.

DEIS: Draft Environmental Impact Statement.

DERMAL: Of the skin.

DEVELOPED RECREATION: Outdoor recreation requiring significant capital investment in facilities to handle a concentration of visitors on a relatively small area. Examples are ski areas, resorts, and campgrounds.

DFTM: Douglas fir tussock moth.

DIAMETER BREAST HEIGHT: (DBH) the diameter of a standing tree at a point 4 feet 6 inches from the ground.

DIPEL: Trade name of biological insecticide formulations containing the bacterium *Bacillus thuringiensis*.

DISPERSED RECREATION: Outdoor recreation in which visitors are diffused over relatively large areas. Where facilities or developments are provided, they are more for access and protection of the environment than for the comfort or convenience of the people.

DIVERSITY: The distribution and abundance of different plant and animal communities and species within the area covered by a land and resource management plan. (36 CFR 219.3).

DOUGLAS FIR TUSSOCK MOTH: a species of moth whose larvae will defoliate coniferous species of trees when populations increase to very high numbers. The typical host type for this species is Douglas fir and true firs.

DRIFT: The movement of air-borne particles from the intended contact area to other areas.

E

ECOSYSTEM: An interacting system of organisms considered together with their environment. For example: marsh, watershed, and lake ecosystems.

ECOLOGICAL DIVERSITY: The numbers and types of ecological communities contained within a specified area.

ECOLOGICAL PROCESSES: The interaction of environmental systems in promoting change in the environment.

ECOSYSTEM: An interacting system of organisms considered together with their environment; (e.g., marsh, watershed, and lake ecosystem).

EFFECTS: Environmental consequences as a result of a proposed action. Included are direct effects, which are caused by the action and occur at the same time and place; indirect effects, which are caused by the action later in time or removed in distance but are reasonably foreseeable. The term's "effects" and "impacts" as used in this statement are synonymous. Effects may be ecological (such as the effects on natural resources and on the components, structures, and functioning of affected ecosystems), aesthetic quality, historic, cultural, economic, social, or health related, whether direct, indirect, or cumulative. Effects resulting from actions may have both beneficial and detrimental aspects, even if on balance the agency believes that the overall effects will be beneficial (40 CFR 1508.8).

EIS: Environmental Impact Statement.

ENDANGERED SPECIES: Any species of animal or plant, which is in danger of extinction throughout all, or a significant portion of its range. Not included are members

of the class of insects, which have been determined by the Secretary to constitute a pest whose protection under the provisions of the Endangered Species Act would present an overwhelming, and overriding risk to humans. The appropriate Federal Agency Secretary must designate an endangered species in the Federal Register.

ENDEMIC: Restricted to and constantly present in a particular locality.

ENVIRONMENT: The aggregate of physical, biological, economic, and social factors affecting all organisms in an area.

ENVIRONMENTAL ANALYSIS: Procedure defined by the National Environmental Policy Act of 1969 whereby the environmental impacts of a planned action are objectively reviewed.

ENVIRONMENTAL ASSESSMENT: A concise public document that provides sufficient evidence and analysis for determining whether to prepare an Environmental Impact Statement or Finding of No Significant Impact. It aids in compliance with the NEPA when no Environmental Impact Statement is needed.

ENVIRONMENTAL IMPACT STATEMENT: A document prepared by a Federal Agency in which anticipated environmental effects of a planned course of action or development are evaluated.

ENVIRONMENTAL PROTECTION AGENCY

(EPA): The Federal Agency with primary responsibility for enforcement of environmental regulations.

EPA: Environmental Protection Agency.

EPIDEMIC: Prevalent and spreading rapidly, widespread.

EXPOSURE: The pathways of human exposure to chemicals are dermal, oral, and inhalation.

F

FEIS: Final Environmental Impact Statement.

FLOODPLAIN: The lowland and relatively flat area adjoining inland waters, including at a minimum, that area subject to a one percent or greater chance of flooding in a given year.

FLUVIAL: Pertaining to streams or rivers, or produced by stream action; also, migrating between main rivers and tributaries.

FORAGE: Food for animals.

FORBS: Non-woody plants, other than grasses. Term refers to feed used by both wildlife and domesticated animals.

FOREGROUND: A term used in visual (scenery) management to describe the stand of trees immediately adjacent to a high-value scenic area, recreation facility, or forest highway (see background and middle ground).

FOREST CANOPY: The crown cover or upper foliage of forest trees.

FOREST LAND: Land at least occupied by forest trees of any size, or formerly having had such tree cover, and not currently developed for non-forest use.

FORMULATION: The form in which a pesticide is packaged or prepared for use.

FRY: Juvenile fish up to the time when the yoke sac has been absorbed.

FUEL LOADING: The amount of fuel present, expressed in terms of weight of fuel per unit area. This may be available fuel or (consumable fuel) total fuel and is usually dry weight.

FUELS: Combustible wildland vegetative materials. While usually applied to above ground living and dead surface vegetation, this definition also includes roots and organic soils such as peat.

G

GAME: Wildlife that are hunted for sport and regulated by state game regulations.

GUIDELINE: An indication or outline of policy or conduct that is not a mandatory requirement (as opposed to a standard, which is mandatory).

H

HABITAT: The place where a plant or animal naturally or normally lives and grows.

HALF-LIFE: The time required for half the amount of substance (such as an insecticide) in, or introduced into a living system, to be eliminated whether by excretion, metabolic decomposition, or other natural processes.

HERITAGE RESOURCES: The cultural foundation of our nation which includes the remains or records of districts, sites, areas, structures, buildings, networks, neighborhoods, memorials, objects and events from the past which have scientific, historic or cultural value. They may be historic, prehistoric, archaeological, or architectural in nature. Heritage resources are considered to be an irreplaceable and nonrenewable aspect of our national heritage.

HIDING COVER: Vegetation capable of hiding 90% of a standing deer or elk from the view of a human at a distance of 200 feet.

HORIZONTAL DIVERSITY: The distribution and abundance of plant and animal communities of successional stages across an area of land; the greater the number of communities, the higher the degree of horizontal diversity.

HOST TYPE: The preferred vegetation of the Douglas-fir tussock moth. In the case of this insect, the preferred species of tree is Douglas fir and true firs (i.e., silver fir, white fir, etc.). (Also, refer to "Percent of Host Type" in this glossary).

HYDROLOGY: The scientific study of the properties, distribution, and effects of water in the atmosphere, on the earth's surface, and in soil and rocks.

I

INDICATOR SPECIES: A wildlife management scheme in which the welfare of a selected species is presumed to indicate the welfare of other species.

INERT INGREDIENT: An ingredient found in a pesticide formulation in addition to the active ingredients, which provides a carrier medium and improves the efficacy of the active ingredient.

INHERENT: Those factors that exist in something as a permanent element.

INSECT DRIFT: Movement of dead or dying aquatic insects within a stream; an occurrence of natural mortality that can be dramatically increased with introduction of toxic substances into a stream.

INSTAR: The term for an insect before each of the molts (shedding of its skin) it must go through in order to increase in size. Upon hatching from its egg, the insect is in instar I and is so called until it molts, when it begins instar II, etc.

INTERACTIONS: Mixtures of chemicals may have substantially different toxicity than the sum of the toxicities of the components. The chemicals may interact to increase toxicity (synergism) or to decrease toxicity (antagonism).

INTERDISCIPLINARY TEAM (I.D. TEAM): A team of people that collectively represent several disciplines and whose duty it is to coordinate and integrate the planning activities.

INTEGRATED PEST MANAGEMENT (IPM): A process for selecting strategies to regulate forest pests in which all aspects of a pest-host system are studied and weighed. The information considered in selecting appropriate strategies includes the impact of the unregulated pest population on various resource values, alternative regulatory tactics and strategies, and benefit/cost estimates for these alternative strategies. Regulatory strategies are based on sound silvicultural practices and ecology of the pest-host system and consist of a combination of tactics such as timber stand improvement plus selective use of pesticides. A basic principle in the choice of strategy is that it be ecologically compatible or acceptable. (36 CFR 219.3)

INTERMITTENT STREAM: A stream that flows above ground at intervals or only flows periodically during the year. In contrast to ephemeral drainages, intermittent streams generally have well-defined channels.

INVERTEBRATE: Major group of animals, of which arthropods are members, characterized by the lack of backbone and spinal column.

IPM: See Integrated Pest Management.

IRRETRIEVABLE: Applies to losses of production, harvest, or use of renewable natural resources. For example, some or all of the timber production from an area is irretrievably lost during the time an area is used as a winter sports site. If the use is changed, timber production can be resumed. The production lost is irretrievable, but the action is not irreversible.

IRREVERSIBLE: Applies primarily to the use of nonrenewable resources, such as minerals or heritage resources, or to those factors, such as soil productivity, that are renewable only over long time periods. Irreversible also includes loss of future options.

ISSUE: A point, matter, or question of public discussion or interest to be addressed or decided through the planning process.

L

LAND ALLOCATION: The assignments of a management emphasis to particular land areas with the purpose of achieving the goals and objectives of the alternative.

LAND MANAGEMENT PLANNING: The process of organizing the development and use of lands and their resources in a manner that will best meet the needs of people over time, while maintaining flexibility for a combination of resources for the future.

LARVA (PLURAL, LARVAE): An insect in the earliest stage of development after it has hatched and before it changes into pupa, a caterpillar, maggot, or grub.

LARGE WOODY DEBRIS: Logs, tree boles, and root wads greater than 4 inches in diameter.

LATE/OLD STRUCTURE: These are timber stands that have some old growth characteristics but have not been designated as old growth in eastside land management plans.

LEPIDOPTERA: A large order of insects, including butterflies and moths, characterized by four scale-covered wings and coiled sucking mouthparts.

M

MAINTENANCE: A strategy used in the alternatives requiring relatively small doses of energy and resources to perpetuate a stable condition.

MANAGEMENT CONCERN: Any factor that is viewed as being detrimental by management.

MANAGEMENT DIRECTION: A statement that includes: multiple use and other goals and objectives, the associated management strategies, and standards and guidelines for attaining them.

MANAGEMENT INDICATOR SPECIES: See indicator species.

MANAGEMENT PRACTICE: A specific action, measure, course of action, or treatment.

MANAGEMENT STANDARDS: A unit of measure used to assess the implementation of a management practice or requirement.

MANAGEMENT STRATEGY: Management practices and intensity selected and scheduled for application on a management area to attain multiple use and other goals and objectives.

MATURE TIMBER: Trees that have attained full development, particularly in height and are in full seed production.

MEAN TREE SIZE: The mathematical average; tree size can be measured by bole diameter, bole height, or basal area.

MESIC: An area that has a balanced supply of water; neither wet nor dry. Can also refer to plants adapted to this environment.

METAPOPOPULATIONS: A population comprised of a set of local populations that are linked by migrants, allowing for re-colonization of unoccupied habitat patches after local extinction events.

MICRON: One millionth of a meter; a micrometer.

MICROORGANISM: A living organism so small it can be seen only with a microscope.

MIDDLEGROUND: The visible terrain beyond the foreground where individual trees are still visible but do not stand out distinctly from the stand.

MINORITY: Persons as specified in Directive 15, Office of Federal Statistical Policy and Standards, U.S. Department of Commerce, Statistical Policy Handbook (1978). Generally identified as one of the following four categories: Alaskan Native or American Indian, Asian or Pacific Islander, Black, Hispanic.

MITIGATION: Actions to avoid, minimize, reduce, eliminate, or rectify the impact of a management practice.

MODIFICATION: A visual quality objective meaning human activity may dominate the characteristic landscape but must, at the same time, utilize natural established form, line, color, and texture. It should appear as a natural occurrence when viewed in foreground or middle ground.

MONITORING: A process to collect significant data from defined sources to identify departures or deviations from expected plan outputs.

MULTI-LAYERED CANOPY: A stand of trees with two or more distinct tree layers in the canopy.

MUNICIPAL WATERSHED: One that serves a public water system as defined in Public Law 93-523 (Safe Drinking Water Act) and associated regulations. Water for human consumption is provided for at least 25 individuals for at least 60 days per year.

N

NATIONAL ENVIRONMENTAL POLICY ACT

(NEPA) (1969): An "Act" to declare a national policy which will encourage productive and enjoyable harmony between humans and the environment. To promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man; to enrich the understanding of the ecological systems and natural resources important to the nation; and to establish a Council on Environmental Quality.

NATIONAL FOREST MANAGEMENT ACT

(NFMA): An "Act" passed in 1976 amending the Forest and Rangeland Renewable Resources Planning Act. NFMA requires the preparation of Regional and Forest Plans and the preparation of regulations to guide that development.

NATURAL FOREST: The condition of a forest environment at any point in time including its associated plant and animal communities, which has been reached essentially through the process of natural succession. This process would include the effects of natural catastrophic occurrences.

NEPA: See National Environmental Policy Act.

NEPA PROCESS: A process, mandated by NEPA, which concentrates decision making around issues, concerns, alternatives, and the effects of alternatives on the environment.

NFMA: See National Forest Management Act.

NO ACTION: no action means any interference with natural processes by humans.

NONTARGET ORGANISMS: The organisms that inhabit the treatment area in addition to the pest species being treated. These organisms could be affected by the insecticide or treatment project.

O

OBJECTIVE: A concise, time-specified statement of measurable planned results that respond to pre-established goals. An objective forms the basis for further planning to define the precise steps to be taken and the resources to be used in achieving identified goals. (36 CFR 219.3)

OLD GROWTH: An old growth stand is defined as any stand of trees 10 acres or greater generally containing the following characteristics: 1) stands contain mature and over-mature trees in the overstory and are well into the mature growth stage; 2) stands will usually contained multi-layered canopy and trees of several age classes; 3) standing dead trees and down material are present; and 4) evidence of human activity may be present; but does not significantly alter the other characteristics and would be a subordinate factor in a description of such a stand.

ORGYIA PSEUDOTSUGATA: Scientific name for the Douglas fir tussock moth.

OVERSTORY: That portion of the trees in a forest of more than one story, forming the upper or uppermost canopy layer.

P

PACIFIC NORTHWEST REGION: Includes the states of Oregon and Washington, portions of two counties in California, and parts of three counties in Idaho. The Region (sometimes called "Region 6") contains 19 National Forests and 1 National Grassland.

PATHOGEN: Any microorganism that can cause disease.

PERCENT OF HOST TYPE: This percentage refers to the percent of a stand that is made up of trees preferred by the tussock moth. Example: If a stand of trees contain 20% Douglas-fir and 80% Ponderosa pine, then the stand is considered containing 20% host type. (Also, refer to "Host Type" in this glossary).

PERENNIAL STREAM: A stream that flows throughout the year.

PHEROMONE: Chemical produced and emitted by female moths to attract male moths for mating.

PLANT COMMUNITIES: A vegetation complex unique in its combination of plants, which occur in particular locations under particular influences. A plant community is a reflection of integrated environmental influences on the site such as soils, temperature, elevation, solar radiation, slope aspect, and rainfall.

POLICY: A guiding principle upon which a specific decision or set of decisions is based.

PM-10: Particles with an aerodynamic diameter smaller or equal to a nominal ten micrometers.

PPB: Parts per billion; the number of parts of a substance per billion parts of a given material. One ppb = 1 µg/liter (water or air).

PPM: Parts per million; the number of parts of a substance in question per million parts of a given material. One ppm = 1 mg/liter (water or air).

PRACTICES: Those management activities that are proposed or expected to occur.

PRESCRIBED FIRE: A wildland fire burning under specified conditions, which will accomplish certain planned objectives. The fire may result from either planned or unplanned ignitions. The Regional Forester must approve proposals for use of unplanned ignitions for this purpose.

PRESCRIBED NATURAL FIRE: The use of unplanned natural ignitions to meet management prescriptions.

PROBABILITY: A number expressing the likelihood of occurrence of a specific event, such as the ratio of the number of experimental results that would produce the event to the total number of events considered possible.

PUBLIC ISSUE: A subject or question of widespread public interest relating to management of the National Forest System.

PUPA (PLURAL PUPAE): The immobile, transformation stage in the development of an insect that, as an adult, is completely different in its appearance compared to what it looked like when it hatched from its egg. Examples include beetles, flies, moths, and wasps.

R

RANGER DISTRICT: An administrative subdivision of the Forest, supervised by a District Ranger who reports to the Forest Supervisor.

RAPTORS: Birds of prey including hawks, eagles, falcons, and owls.

REGENERATION: The actual seedlings and saplings existing in a stand; or the act of establishing young trees naturally or artificially.

REGIONAL OFFICE: An administrative subdivision of the National Forest System, supervised by a Regional Forester who reports to the Chief of the Forest Service.

REINVASION: The movement of an organism from adjacent populations back into an area where the organism has been excluded.

RESEARCH NATURAL AREA (RNA): An area of land in as near a natural condition as possible that exemplifies typical or unique vegetation and associated biotic, soil, geologic, and aquatic features. The area is set aside to preserve a representative sample of an ecological community primarily for non-manipulative scientific and education purposes.

RESIDENT TROUT: A trout, which spends its entire life in fresh water.

RESIDUAL: Refers to remaining.

RESURGENCE: The growth of a population back to pre-treatment levels from a resident population.

RIPARIAN: Pertaining to areas of land directly influenced by water. Riparian areas usually have visible vegetation or physical characteristics reflecting this water influence. Streamside, lake borders, or marshes and wetlands are typical riparian areas.

RIPARIAN AREA: Geographically delineated areas, with distinctive resource values and characteristics that are comprised of aquatic and riparian ecosystems. Generally, on National Forests, riparian areas include lands adjacent to all streams, lakes, and ponds and areas comprising seeps, springs, and wetlands.

RIPARIAN ECOSYSTEMS: A transition between the aquatic ecosystem and the adjacent upland terrestrial ecosystem. Identified by soil characteristics and distinctive vegetation communities that require free or unbound water.

RIPARIAN VEGETATION: Vegetation growing on or near the banks of a stream or body of water on soils that exhibit some wetness characteristics during some portion of the growing season.

RISK: The degree and probability of loss based on chance.

RISK ASSESSMENT: An analytic process that is firmly based on scientific considerations, but requires judgment when available information is incomplete. These judgments inevitably draw on both scientific and policy considerations.

RNA: Refer to Research Natural Area.

RUNOFF: The flow or discharge of water from an area, including both surface and subsurface flow.

S

SAFETY FACTOR: A factor conventionally used to extrapolate human tolerances for chemical agents from “No Observed Effect Levels” in test animals.

SALMONID FISH: Fish having salmon-like characteristics- includes the trout, salmon, and whitefish.

SCENIC AREAS: Places of outstanding or matchless beauty, which require special management to preserve these qualities. They may be established under 36 CFR 294.1 whenever lands possessing outstanding or unique natural beauty warrant this classification.

SCOPING: An integral part of environmental analysis. Scoping entails: Examining a proposed action and its possible effects; establishing the depth of environmental analysis needed; and determining analysis procedures, data needs, and task assignments.

SCOPING PROCESS: Determining the extent of analysis necessary for an informed decision of a proposed action. The process includes: 1) Reviewing present management direction as it relates to the analysis; 2) Contacting interested or affected public participants by the proposed action to glean opinions or issues with the proposed action; 3) Determining local management concerns. This process continues throughout analysis until a decision is made.

SECOND GROWTH: Forest growth that has grown naturally after some drastic interference with the previous forest growth (e.g., fire, insect attack, and cutting).

SEDIMENT: Solid material, both mineral and organic, that is in suspension, and is being transported from its site of origin by air, water, gravity, or ice, or has come to rest on the earth's surface either above or below sea level.

SENSITIVE SPECIES: Those species of plants or animals that have appeared in the Federal Register as proposed for classification and are under consideration for official listing as endangered or threatened species that are on an official State list or that are recognized by the Regional Forester as needing special management to prevent their being placed on Federal or State lists.

SERAL: A biotic community, which is a developmental, transitory stage in an ecological succession.

SEVIN 4-OIL™: Commercial insecticide formulation containing the active ingredient carbaryl.

SHPO: The "State Historic Preservation Officer". The official appointed or designated pursuant to Section 101(b)(1) of the National Historic Preservation Act to administer the State historic preservation program or a representative designated to act for the SHPO. Among other duties, the State Historic Preservation Officer advises and assists Federal agencies and State and local governments and cooperates with these agencies and others to ensure that historic properties are considered at all levels of planning and development.

SNAG: A standing dead tree.

SPREADER/STICKER AGENT: Substances that improve the performance of the pesticide. They are added to the spray tank, separate from the pesticide formulation. Spreader causes the formulation to spread out more to increase coverage; sticker increases the adhesion or “stickiness” of the pesticide.

SERAL STAGE: An identifiable step in succession.

STAND: Timber possessing uniformity as regards to type, age class, risk class, vigor, size class, and stocking class.

STANDARD: A principle requiring a specific level of attainment, a rule to measure against.

STRUCTURAL DIVERSITY: Diversity in a forest stand that results from layering or tiering of the canopy; an increase in layering or tiering leads to an increase in structural diversity (Thomas 1979), (Brown 1985).

STRUCTURE: The configuration of elements, parts, or constituents of a habitat, plant or animal community of forest stands (adapted from Thomas 1979). (Brown 1985)

SUCCESSION: A sequence of vegetative change that proceeds following a disturbance.

SUPPRESSED TREES: Trees in a forest stand whose crowns are below the general level of the canopy; growth is inhibited due to competition for a limited resource such as sunlight; such trees are weak, slow growing, and often die.

T

THERMAL COVER: Vegetation that provides wildlife shelter from climatic conditions.

THREATENED SPECIES: Any species listed in the Federal Register, which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

THRESHOLD: This is the point on a dose-response curve, above, which effects occur and below which no effects occur.

TIERING: Refers to the coverage of general matters in broader environmental impact statements (such as National program or policy statements) with subsequent narrower statements or environmental analysis (such as regional or basin-wide program statements or, ultimately, site-specific statements) incorporating by reference the general discussions and concentrating solely on the issues specific to the statement subsequently prepared.

TOLERANCE: Forestry term for expressing the relative capacity of a tree to compete under low light and high root competition.

TOLERANT SPECIES: Plants that grow well in shade.

TOXIC: Relating to a harmful effect by a poisonous substance on the human body by physical contact, ingestion, or inhalation.

TOXICANT: A poison; toxic agent.

TOXICOLOGY: The study of the nature and detection of poisons and the treatment of poisoning.

TRUE FIR: Those species of trees such as white, silver, and grand fir located on high-elevation soil sites. A specific ecological plant community.

U

UNCERTAINTY: May be due to missing information, or gaps in scientific theory. Whenever uncertainty is encountered, a decision, based upon scientific knowledge and policy considerations must be made. The term, scientific judgment, is used to distinguish this decision from policy decisions made in risk management.

UNDERBURN: Process where fire, either natural or prescribed, burns hot enough so that vegetation under a stand of timber is either killed and/or consumed yet the fire is not hot enough to kill the trees in the overstory.

UNDERSTORY: Vegetation growing under a higher canopy.

USDA: United States Department of Agriculture.

USDI: United States Department of the Interior.

V

VERTEBRATES: Those organisms having a spinal column protected by bone or cartilage.

VERTICAL STRUCTURE: Recognizable layers of vegetation, including overstory, understory, shrub and herb layers.

VIEWSHED: The total landscape seen, or potentially seen, from all or a logical part of a travel route, use area, or water body.

VISIBILITY: How far the human eye can see a given object. The greatest distance in a given direction at which

it is just possible to see and identify with the unaided eye in the daytime, a prominent dark object and, at night, a known, preferably unfocused, moderately intense light source.

VISUAL QUALITY OBJECTIVE: A combination of inherent scenic quality and public interest that defines the acceptable degree of alteration for and given area.

VISUAL RESOURCE (FOREST SCENERY): The composite of basic terrain, geologic features, water features, vegetative patterns, and land use effects that typify a land unit and influence the visual appeal the unit may have for visitors. Visual resource categories include Retention, Partial Retention, and Modification.

W

WATER QUALITY: The biological, physical, and chemical properties of water that make it suitable for given specified uses. Definition of water quality for forest areas is difficult because of the wide range of downstream uses.

WATERSHED: The line separating head-streams which flow to different river systems, it may be sharply defined (crest of a ridge), or indeterminate (in a low undulating area).

WESTERN SPRUCE BUDWORM: (*Choristoneura occidentalis*) a member of the Lepidoptera family that defoliates and damages the cones of several species of conifers. (Forest Insect and Disease Leaflet 53).

WETLANDS: Those areas that are inundated by surface or ground water with a frequency sufficient to support, and under normal circumstances do or would support, a prevalence of vegetation or aquatic life. These organisms require saturated or seasonally saturated soil conditions for growth and reproduction. Wetlands generally include swamps, marshes, bogs, and similar areas such as sloughs, potholes, wet meadows, river overflows, mud flats, and natural ponds.

WILD AND SCENIC RIVERS: Those rivers or sections of rivers designated as such by congressional action under the 1968 Wild and Scenic Rivers Act, as supplemented and amended, or those sections of rivers designated as wild, scenic, or recreational by an act of the Legislature of the state or states through which they flow.

WILDERNESS: Areas designated by congressional action under the 1964 Wilderness Act. Wilderness is defined as undeveloped Federal land retaining its primeval character and influence without permanent improvements or human habitation. Wilderness areas are protected and managed to preserve their natural conditions, which generally appear to have been affected primarily by the forces of nature, with the imprint of human activity substantially unnoticeable, have outstanding opportunities for solitude, or for a primitive and unconfined type of recreation; include at least 5,000 acres or are of sufficient size to make practical their preservation, enjoyment, and use in an unimpaired condition; and may contain features

of scientific, educational, scenic, or historical value as well as ecological and geologic interest.

WILDFIRE: Any wildland fire that requires a suppression response.

WINTER RANGE: The area available to and used by big game through the winter season

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APPENDIX A: ACRES PROTECTED, BY FOREST LAND MANAGEMENT AREA

Table A-1: Colville NF – Acres in Forest Plan Management Allocations

LAND ALLOCATION (MANAGEMENT AREA #)	ACRES IN HOST TYPE No ACTION	PROPOSED ACTION & TM-BIOCONTROL ONLY ALT. ACRES PROTECTED	EXPANDED PROTECTION ALTERNATIVE ACRES PROTECTED
Old Growth Dependent Species Habitat (MA 1)	21,070	540	19,580
Caribou Habitat (MA 2)	18,380	0	18,380
Recreation (MA 3A)	24,540	1,725	22,240
Recreation/Wildlife (MA 3B)	5,930	0	4,890
Downhill Skiing (MA 3C)	1,340	0	1,340
Research Natural Area (MA 4)	2,400	0	0
Scenic/Timber (MA 5)	120,010	2,680	114,500
Scenic/Winter Range (MA 6)	46,150	1,410	42,800
Wood/Forage (MA 7)	235,080	380	219,940
Winter Range (MA 8)	70,860	525	62,240
Wilderness Management (MA 9)	21,860	0	0
Semi-Primitive, Motorized Recreation (MA 10)	6,520	0	5,690
Semi-Primitive, Non-Motorized Recreation (MA 11)	47,420	0	46,850
TOTAL	621,560	7,260 1.2%	558,450 89.8%

Table A-2: Okanogan NF – Acres in Forest Plan Management Allocations

LAND ALLOCATION (MANAGEMENT AREA #)	ACRES IN HOST TYPE NO ACTION	PROPOSED ACTION & TM-BIOCONTROL ONLY ALT. ACRES PROTECTED	EXPANDED PROTECTION ALT. ACRES PROTECTED
Semi-Primitive, Non-Motorized Recreation (MA 4)	670	0	660
Visual Quality (MA 5)	34,730	32,110	34,530
Research Natural Areas (MA 8)	3,260	0	0
Bighorn Sheep Habitat (MA 11)	1,530	0	1,240
Lynx Habitat (MA 12)	7,120	0	6,450
Wildlife Habitat (MA 14)	61,220	390	49,250
Wilderness (MA 15, 40, 41)	35,960	5,860	5,860
Developed Recreation in Roaded Setting (MA 17)	1,740	1,740	1,740
Plant Communities (MA 18)	30	0	30
Minerals Exploration (MA 24)	2,580	0	2,270
Timber and Range (MA 25)	116,930	210	96,960
Deer Winter Range (MA 26)	35,150	20	29,410
Northwest Forest Plan (MA 30 - 50, except 40 & 41)	192,250	81,740	155,360
TOTAL	493,170	122,070 24.7%	383,760 77.8%

Table A-3: Wenatchee NF – Acres in Forest Plan Management Allocations

LAND ALLOCATION (MANAGEMENT AREA #)	ACRES IN HOST TYPE NO ACTION	PROPOSED ACTION & TM-BIOCONTROL ONLY ALT. ACRES PROTECTED	EXPANDED PROTECTION ALT. ACRES PROTECTED
Experimental Forest (EF-1)	150	0	0
Key Deer and Elk Habitat (EW-1)	20,390	8,490	13,000
Key Big Game Habitat/Unroaded (EW-3)	4,000	3,820	3,940
General Forest (GF)	59,240	38,520	46,730
Mather Memorial Parkway (MP-1)	1,100	920	950
Old Growth Management (OG-1)	110	90	90
Developed Recreation (RE-1)	180	0	15
Dispersed Recreation, Unroaded, Motorized (RE-2)	2,450	1,680	2,100
Dispersed Rec., Unroaded Non-Motorized (RE-3)	8,250	5,960	7,070
Dispersed Recreation/Unroaded/ Timber Harvest (RE-4)	670	660	660
Intensive Range Management (RM-1)	670	0	170
Research Natural Areas	230	0	0
Classified Special Areas – Scenic and/or Recreation (SI-1)	6,950	1,410	6,235
Classified Special Area – Other (SI-2)	970	830	890
Scenic Travel – Retention (ST-1)	16,160	10,780	12,330
Scenic Travel – Partial Retention (ST-2)	34,130	17,540	27,640
Wilderness (WI-1)	17,230	0	0
Scenic River (Proposed) (WS-1)	840	550	740
Recreation River (Proposed) (WS-2)	2,290	1,910	1,960
Other	610	170	380
TOTAL	176,620	93,330 52.89%	124,900 70.7%

Table A-4: Umatilla NF – Acres in Forest Plan Management Allocations

LAND ALLOCATION (MANAGEMENT AREA #)	ACRES IN HOST TYPE NO ACTION	PROPOSED ACTION & TM-BIOCONTROL ONLY ALT. ACRES PROTECTED	EXPANDED PROTECTION ALT. ACRES PROTECTED
Non-Motorized Dispersed Recreation (A 1)	20,590	1,050	17,720
OHV Recreation (A 2)	3,780	3,775	3,775
View shed 1 (A 3)	21,950	21,800	21,850
View shed 2 (A 4)	17,280	17,280	17,280
Roaded Natural (A 5)	4,130	180	2,780
Developed Recreation (A 6)	2,820	2,750	2,810
Wild & Scenic Rivers (A 7)	2,590	1,150	1,150
Scenic Area (A 8)	21,420	21,410	21,410
Special Interest Area (A 9)	2,110	170	1,275
Wenaha-Tucannon Special Management Area (A 10)	2,800	5	2,020
Wilderness (B 1)	236,650	5,890	5,890
Dedicated Old Growth (C 1)	32,140	15,560	27,860
Managed Old Growth (C 2)	1,870	110	690
Big Game Winter Range (C 3)	54,840	1,220	30,490
Wildlife Habitat (C 4)	171,780	8,430	113,950
Riparian (Fish & Wildlife) (C 5)	17,430	2,820	13,140
Special Fish Management Area (C 7)	54,610	800	18,920
Grass-Tree Mosaic (C 8)	46,850	14,660	40,930
Research Natural Area (D 2)	6,200	0	0
Timber & Forage (E 1)	42,250	430	32,280
Timber & Big Game (E 2)	124,600	1,040	65,740
Mill Creek Municipal Watershed (F 2)	6,670	6,590	6,670
High Ridge Evaluation Area (F 3)	590	180	320
Walla Walla River Watershed (F 4)	26,880	1,020	23,430
Other	6,830	1,990	7,460
TOTAL	931,870	130,310 14.0%	479,840 51.5%

Table A-5: Wallowa-Whitman NF – Acres in Forest Plan Management Allocations

LAND ALLOCATION (MANAGEMENT AREA #)	ACRES IN HOST TYPE NO ACTION	PROPOSED ACTION & TM-BioCONTROL ONLY ALT. ACRES PROTECTED	EXPANDED PROTECTION ALT. ACRES PROTECTED
Timber Production Emphasis (MA 1, 1W)	398,080	46,040	214,510
Wildlife/Timber (MA 3, 3A)	167,460	19,760	89,780
Wilderness (MA 4)	130,380	0	0
Phillips Lake Area (MA 5)	20	0	0
Back Country (MA 6)	30,040	9,030	17,540
Wild & Scenic Rivers (MA 7)	10,670	10,240	10,290
HCNRA, Snake River Corridor (MA 8)	10	0	0
HCNRA, Dispersed Recreation/Native Vegetation (MA 9)	48,100	0	40,210
HCNRA, Forage Production (MA 10)	48,610	1,850	26,930
HCNRA, Dispersed Recreation/Timber Management (MA 11)	44,940	5,240	31,390
Research Natural Areas (MA 12)	1,110	0	0
Homestead Further Planning Area (MA 13)	390	0	180
Starkey Experimental Forest & Range (MA 14)	13,810	0	7,420
Old Growth Preservation (MA 15)	42,770	13,620	28,960
Administrative & Recreation Site Retention (MA 16)	280	70	100
Power Transportation Facility Retention (MA 17)	1,670	10	690
Anadromous Fish Emphasis (MA 18)	21,360	4,660	11,070
TOTAL	959,700	110,520 11.5%	479,070 49.9%

Table A-6: Malheur NF – Acres in Forest Plan Management Allocations

LAND ALLOCATION (MANAGEMENT AREA #)	ACRES IN HOST TYPE NO ACTION	PROPOSED ACTION & TM-BIOCONTROL ONLY ALT. ACRES PROTECTED	EXPANDED PROTECTION ALT. ACRES PROTECTED
General Forest / Rangeland	357,990	23,200	164,230
Big Game Winter Range Maintenance (MA 4A)	74,390	1,180	31,470
Strawberry Mountain Wilderness (MA 6A)	44,890	0	0
Monument Rock Wilderness (MA 6B)	10,890	0	0
Scenic Area (MA 7)	2,800	70	1,140
Research Natural Areas (MA 9)	560	0	0
Semi-Primitive Non-Motorized Rec. Areas (MA 10)	17,570	1,620	10,840
Semi-Primitive Motorized Recreation Areas (MA 11)	8,390	1,590	4,845
Old Growth (MA 13)	52,690	11,060	36,940
Visual Corridors (MA 14)	96,320	27,030	56,000
Byram Gulch Municipal Supply Watershed (MA 17)	150	150	150
Long Creek Municipal Supply Watershed (MA 18)	230	0	110
Dry Cabin & Utley Butte Wildlife Emphasis Areas (MA 20A&B)	7,430	250	5,240
Wildlife Emphasis Area (MA 21)	23,750	5,260	16,360
Wild and Scenic River (MA 22)	7,220	1,340	5,740
Other	800	160	825
TOTAL	706,070	72,910 10.3%	333,890 47.3%

Table A-7: Ochocho NF – Acres in Forest Plan Management Allocations

LAND ALLOCATION (MANAGEMENT AREA #)	ACRES IN HOST TYPE NO ACTION	PROPOSED ACTION & TM-BIOCONTROL ONLY ALT. ACRES PROTECTED	EXPANDED PROTECTION ALT. ACRES PROTECTED
Wilderness (F 1)	16,490	0	0
Research Natural Areas (F 5)	1,080	0	0
Old Growth (F 6)	5,760	4,720	4,970
Summit National Historic Trail (F 7)	2,810	2,810	2,810
Rock Creek/Cottonwood Creek Area (F 8)	5,550	5,050	5,190
Silver Creek Roadless Area (F 10)	20	20	20
Lookout Mountain Recreation Area (F 11)	7,480	7,000	7,170
Eagle Roosting Areas (F 12)	5	0	0
Developed Recreation (F 13)	200	200	200
Riparian (F 15)	4,130	2,930	3,130
Bandit Springs Recreation Area (F 16)	270	90	120
Stein's Pillar Recreation Area (F 17)	420	290	310
Hammer Creek Wildlife/Recreation Area (F 18)	110	100	100
Deep Creek Recreation Area (F 19)	110	40	50
Winter Range (F 20)	1,090	610	670
General Forest Winter Range (F 21)	4,740	1,620	1,990
General Forest (F 22)	55,890	35,020	40,200
N. Fork Crooked River Recreation Corridor (F 23)	40	20	20
North Fork Crooked River Scenic Corridor (F 24)	60	40	40
Highway 26 Visual Corridor (F 25)	1,530	1,530	1,530
Visual Management Corridors (F 26)	3,000	2,995	3,000
Round Mountain National Recreation Trail (F 27)	490	490	490
Facilities (F 28)	15	5	10
Other	1,410	1,100	1,240
TOTAL	112,700	66,680 61.2%	73,260 67.0%

Table A-8: Winema NF Acres in Forest Plan Management Allocations

LAND ALLOCATION (MANAGEMENT AREA #)	ACRES IN HOST TYPE NO ACTION	PROPOSED ACTION & TM-BIOCONTROL ONLY ALT. ACRES PROTECTED	EXPANDED PROTECTION ALT. ACRES PROTECTED
Semi-Primitive Recreation Area (MA 1)	9,750	0	5,190
Developed Recreation (MA 2)	1,570	0	1,200
Scenic Management (MA 3)	30,100	860	6,030
Unique Management Areas (MA 4)	6,940	30	30
Wilderness (MA 6)	22,940	0	0
Old Growth Ecosystems (MA 7)	8,760	3,030	3,040
Riparian Areas (MA 8)	950	0	60
Bald Eagle Habitat (MA 9)	12,430	370	1,750
Big Game Winter Range (MA 10)	2,030	1,290	1,290
Timber Production (MA 12)	89,520	18,030	23,440
Research Natural Areas (MA 13)	720	0	0
Upper Williamson (MA 15)	90	0	0
Late Successional Reserves (MA 16)	44,080	0	24,930
Riparian (MA 18)	7,470	1,000	4,240
TOTAL	237,350	24,610 10.4%	71,200 30.0%

Table A-9: Fremont NF – Acres in Forest Plan Management Allocations

LAND ALLOCATION (MANAGEMENT AREA #)	ACRES IN HOST TYPE NO ACTION	PROPOSED ACTION & TM-BIOCONTROL ONLY ALT. ACRES PROTECTED	EXPANDED PROTECTION ALT. ACRES PROTECTED
Mule Deer Forage and Cover on Winter Range (MA 1)	1,540	0	30
Old Growth Habitat for Dependent Species above the Management Requirement Level (MA 3)	140	0	0
Scenic Viewsheds (MA 6)	1,320	190	820
Wilderness (MA 10)	710	0	0
TOTAL	3,710	190 5.4%	850 23.2%

APPENDIX B: TUSSOCK MOTH INFORMATION

Outbreaks of the Douglas-fir tussock moth occur periodically. Many people who lived in eastern Oregon still remember the tussock moth outbreak in the early 1970's. Others relate their concerns with the Douglas-fir tussock moth in the context of their experience with another major forest defoliator, the western spruce budworm *Choristoneura occidentalis* Freeman. It is important to understand the differences of the biology and life histories of these two insects in order to address some of these concerns.

Some of the questions that arise when talking about potential spray projects are:

- What is the effectiveness of the proposed treatment in achieving the objective;
- Will insect populations come back after treatment;
- What are treatment effects on the natural predators and parasites;
- Will the treatment contribute to the longer-term resistance of the insect to the insecticide?

In order to address these questions, a review of information on such things as past outbreaks and treatments, insect biology, and natural control factors was conducted.

DOUGLAS FIR TUSSOCK MOTH OUTBREAKS

Douglas-fir tussock moth outbreaks occur periodically, approximately every 7-11 years (Mason and Luck, 1978; Swetnam, et.al., 1995; Mason, et.al., 1997). These outbreaks last for 3-4 years and then collapse. The collapse is dramatic, and insects are very rare and difficult to find during non-outbreak periods. Outbreak patterns of DFTM over western North America historically appear to be synchronous, particularly in British Columbia, Washington, Oregon, and northern Idaho. Populations increase to outbreak and collapse in a variable cycle on an average of every 9 years. The dates most outbreaks begin may vary slightly between regions, but most outbreaks end the same year (Shepherd, et.al, 1988).

The Douglas-fir tussock moth belongs to the category of what are referred to as "*fast-cycling*" insects as opposed to the western spruce budworm, which is a "*sustained cycle*" insect (Shepherd, 1994). The difference in these two types of characteristics determines the appropriateness and success of a proposed treatment. Characteristics of a "*fast-cycling*" insect are that populations are explosive in nature, increasing very quickly, causing severe defoliation and mortality in just one or two years, and then, just as quickly, collapsing. A sustained-cycle insect outbreak builds up more slowly, and lasts for a longer period of time. Severe damage appears only after a number of years of defoliation and impact is related more to duration of defoliation, rather than intensity of defoliation, as occurs in

the Douglas-fir tussock moth (Shepherd, 1994). This difference is due, in part, to feeding habits. The western spruce budworm feeds only on the new buds and growth each year, and does not feed on the older needles; thus, it is over a period of several years, after older needles begin to drop naturally, and are not replaced by newer ones, that the tree begins to take on an overall defoliated appearance. Young Douglas-fir tussock moth larvae begin by feeding on the younger, tender new growth, but as they mature, they actively feed on the older needles and can completely defoliate a tree within a couple months. Partial defoliation, at least over a short period of time, is probably not detrimental, and may be somewhat beneficial to the tree. The physiological responses of a tree that receives only partial defoliation (western spruce budworm) versus one that receives severe defoliation would be different (Parks, et.al. 1994). In addition, western spruce budworm outbreaks are speculated to decline from lack of quality food and possibly a weather-related occurrence. It is also likely that because of the longer outbreak cycle, natural parasites and predators are able to develop and catch up with their host population. On the other hand the Douglas-fir tussock moth develops high numbers of individuals at one time causing competition for food and creating an opportunity for a contagion to spread quickly. As a means of comparison, when monitoring insect population numbers, an "outbreak" of western spruce budworm often measures 20-60 larvae per square meter of foliage, but can reach numbers as high as 200. A tussock moth outbreak often measures as many as 150-600 larvae per square meter of foliage.

NATURAL CONTROL

There are a number of fungi and viruses that affect the western spruce budworm, however, because they are individual feeders that remain isolated from each other for much of their life cycle, it is difficult for an epizootic to become established in the population (Fleming, 1985), and viruses do not play a major role in the outbreak cycle.

In contrast, the Douglas-fir tussock moth virus is one of the most virulent viruses known (cited in Hughes, 1978), and its role in the collapse of DFTM outbreak populations is well documented. It has been reported as the reason collapse of outbreaks in Washington, Oregon, Montana, Idaho, California, and British Columbia (cited in Torgersen and Dahlsten, 1978). As early as an outbreak in 1929, in Idaho, Blach (1932) noticed the ground covered with living and dead caterpillars, many of which had died from starvation, or apparently were diseased. Steinhaus first reported a nuclear polyhedrosis virus in tussock moth larvae collected in Washington, Oregon, and Idaho in 1947 (cited in Thompson, 1978). The virus has been reported in association with almost every outbreak since. Apparently, in the absence of extremely high populations and the virus, the outbreak can continue past the normal 3-4 year cycle.

One outbreak in New Mexico persisted for a number of years, slowly spreading from ornamentals in the city of Los Alamos, where it was first noticed in 1968, to trees in the adjacent canyons. This infestation did not exhibit the 3 year outbreak cycle pattern characteristic of outbreaks elsewhere, where populations are brought under control by an epizootic of virus. Tests on the populations found no incidence of virus in 1977 or the spring of 1978 (Hofacker, et al., 1979).

The virus persists in the soil at very low levels between DFTM outbreaks. Thompson and Scott (1979) found that only a very small amount of the virus produced in an epizootic (1%) survived the first year in the soil. However, once it was safely ensconced in the forest duff layer, it was amazingly persistent. They found that 11 years after an epizootic, nearly 1/3 of the active virus surviving the first year in the duff, was still active, and nearly 1/2 had not become incorporated any deeper than the first inch of mineral soil. In a later study, (Thompson, et al, 1981) sampled the soil in an area where the last DFTM outbreak and epizootic had occurred over 40 years earlier, in 1937-38. In these studies, they found barely detectable (less than 45 polyhedral inclusion bodies/cm³) in 12 of the 15 positive bioassay samples. By comparing the virus survival to other outbreak areas, results suggest that about 50-75% of the active virus in the soil is lost in the first 10 years, and more than 99% in 41 years. Even after 41 years, however, soil samples from sheltered locations still contained enough active virus to infect tussock moth larvae. This suggests that the virus may be a natural component of the forest ecosystem for a long time, but is then reintroduced into the forest canopy during a subsequent outbreak.

Thompson and Scott (1979) also found that virus produced by different age classes varied. The virus produced in the early larval instars was largely inactivated on the foliage, presumably by solar radiation, and never became incorporated in the duff, at least while it was still active. These smaller larvae do not fall from the foliage, but their bodies remained glued to needles where other larvae were likely to encounter the virus. A larger amount of the virus is produced in older larvae and is subsequently incorporated into the duff when they die. As older larvae die from virus infection, they hang; head down, with their posterior abdominal prolegs attached to the foliage. After death, they fall to a lower branch or the forest floor. They usually rupture, and their liquefied body contents splatter into the organic litter on the forest floor or onto an adjacent branch (Thompson, 1978).

Soil samples taken in various places within a previous outbreak demonstrate that different site conditions can affect the survival of the virus. Fifty soil samples from around charred stumps showed no polyhedrosis virus, while a series of samples taken under green timber immediately adjacent to the burned area showed virus in 49 of the 50 samples; a forest fire severe enough to burn down to the mineral soil can completely eliminate the residue of active virus in the forest floor (Thompson and

Scott, 1979). In addition, of soil samples taken from young pole thickets, beneath exposed large individual trees, within clusters of large trees, and in disturbed (past salvage/logging activity) soil, and soil covered with a heavy duff layer, only samples from undisturbed soil beneath clusters of large trees in full or nearly full shade, still contained active virus (Thompson, et. al., 1981). In some cases, DFTM outbreaks controlled by the virus occur in areas where there has been no previously recorded outbreak; whether the virus is somehow transported there through air currents, or is residual from an outbreak from years before recording began, or is somehow maintained in the very low DFTM populations indigenous to that area, or a combination of these factors, is less sure.

Two distinct nuclear polyhedrosis viruses (NPV) affect the DFTM and a couple other members of the *Orgyia* genus. Both are in the genus *Baculovirus*, Subgroup A, which includes all nuclear polyhedrosis viruses. The morphological distinction between the two is in the way the virus particles are enveloped. In one, each rod-shaped nucleocapsid is enveloped, individually. This is the unicastid morphotype designated SV (for single-rod virus). The second is a multicapsid virus with the nucleocapsid occurring in bundles or packets of two or more rods in a single envelope. These are designated BV (or bundled virus). Both are highly infectious, however, the BV appears to be slightly more infectious and was the one selected for development for eventual registration as TM BioControl (Hughes, 1978). BV is one of the most infectious viruses known and only a few polyhedra in the gut of a larva (perhaps fewer than 10) can initiate infection. They are infective to all instars, and pupae frequently die, presumably because they were infected late in the larval life. Adults are not known to have naturally occurring, clinically evident infections (Hughes, 1978). Complete resistance of tussock moth has not been found, either in extensive laboratory rearing or in field populations.

Undoubtedly the virus is the most important natural cause of the frequently observed, dramatic decline of DFTM populations that characteristically terminates a major DFTM outbreak. If the virus were not present in such situations, it is likely that other control factors would take over, although the response would be slower and they would not exert their influence as quickly as the virus. The virus does not appear to be a significant factor in endemic populations or sporadic flare-ups. Other factors, usually a complex of parasites, apparently act significantly on populations during these situations (Wickman, et.al., 1973; Mason, et. al., 1983). The Douglas-fir tussock moth has a number of insect parasites. A solitary egg parasite, *Telenomus californicus* Ashmead, is the most dominant and extremely efficient parasite (Torgersen and Dahlsten, 1978, Torgersen and Mason, 1985). Even when host insects are sparse, over 90% of egg masses may be attacked and 50% of the total egg mass complement may be destroyed (cited in Torgersen and Dahlsten, 1978). It over winters as the adult female and actively searches for and parasitizes eggs both in the fall, and in the spring up

until just prior to egg hatch (Torgersen and Ryan, 1981). The Douglas-fir tussock moth is apparently the only host for this parasite (Torgersen, 1981; Torgersen and Ryan, 1981). A Dipteran parasite, *Agria housei* Shewall, is a significant parasite of cocoons, sometimes causing 64-96% cocoon mortality (Torgersen, 1981). Torgersen (1981) listed about 88 species of parasites of Douglas-fir tussock moth that attack various life stages (eggs, larvae and pupae) of the DFTM. Different parasites can vary as the dominant parasite species in various geographic regions (cited in Torgersen and Dahlsten, 1978).

A variety of arthropods and insects, such as spiders and ants cause varying amounts of predation on DFTM life stages; however, insectivorous birds are a major source of mortality at low host densities. Birds prey on all host stages and estimates of predation range from 3 – 30% on eggs, 19% on late instar larvae, and 19 to 49% on pupae (cited in Torgersen and Dahlsten, 1978; Torgersen, et. al., 1983). This complex of predators and parasites undoubtedly maintains the DFTM populations at low levels during non-outbreak years, and is what continues to keep the populations down once an intervening factor such as starvation, virus, or treatment has brought the high outbreak populations down.

Other factors that have been determined to contribute significantly to mortality are early instar dispersal and starvation, secondary effects from food stress such as reduced fecundity, and sometimes weather factors such as frost damage to new foliage or, in one instance, consecutive days of extreme heat (cited in Torgersen and Dahlsten, 1978).

Insectivorous birds and ants are significant predators of fourth instar larvae through pupae at low population levels of western spruce budworm, but have much less influence at high populations (Torgersen, 1985a). Parasites do serve to keep the populations down, however, studies on parasitoids of various life stages of western spruce budworm suggest that parasites contributed little to variation in survival rates from fourth instar to adults, or the overall generation during outbreaks; and on a broad range of densities parasitism may have a less significant role (cited in Torgersen, 1985b).

TREATMENT OF PREVIOUS OUTBREAKS

Douglas-fir tussock moth suppression projects have been conducted periodically throughout Idaho, Oregon, Washington, California and British Columbia. From 1947 until 1974, DDT was the primary insecticide used, although tests and pilot projects using alternative chemical insecticides such as mexacarbate, trichlorfon, and carbaryl (Ciesla, 1978), as well as *Bacillus thuringiensis* and the virus were conducted. In almost all cases, treatment during operational projects was applied during the decline phase of the outbreak cycle. Generally, the need to control the outbreak was not recognized until after the first year of heavy defoliation was evident; subsequently, treatments were not applied until the following year. It is doubtful that any benefit was gained from treatment in these

circumstances. Most defoliation and tree mortality occurs during the first year of heavy defoliation (Wickman, 1978). An insignificant amount of foliage protection may occur when treating in the year of the population decline, but it is doubtful that it is of any benefit. If foliage protection is an objective for treatment, it must take place prior to significant defoliation.

Although DDT was the primary insecticide used on larger outbreaks, as early as the 1960's projects using TM-BioControl were conducted. Approximately 4,400 acres were treated with TM-BioControl at Wheeler Peak, NV in 1960; and an aerial application of TM-BioControl, which appeared to have effectively reduced populations, was applied to over 12,500 acres on the Boise NF in 1963 (Tunnock, et. al., 1985). In the 1970s, several small studies using TM-BioControl in various formulations were conducted throughout Oregon, British Columbia, and California (Stelzer and Neisess, 1978a). In 1978, TM-BioControl was used in a pilot project near Los Alamos, NM (Hofacker, et. al., 1979) and in 1979; TM-BIOCONTROL was used operationally to control DFTM in Bear Canyon, west of Albuquerque, NM and on the Santa Fe NF near Los Alamos, NM (Hofacker, et. al., 1980). A test using TM-BioControl against the early stage of the outbreak cycle was conducted in B.C. in 1981 (Shepherd, et. al., 1984). In this study, populations were effectively controlled, while populations in the check plots continued to increase the following year until the natural epizootic occurred. It was also tested in Idaho in 1986, and 1991 (Beckwith, et.al. unpublished).

B.t.k. was field tested on various occasions in the early 1970's along with TM-BioControl (Stelzer and Neisess, 1978b). Additionally, it was used operationally in 1989 on 84,000 acres on the Plumas NF. Ninety percent mortality was achieved and severe defoliation was prevented (Hofacker, et. al., tech. coord.1990). In 1991, 116,000 acres were treated with B.t.k. on the Wallowa-Whitman NF (Hofacker, et.al. tech. coordinator. 1992).

Between 1983 and 1993, evaluation and suppression projects using B.t.k. were conducted for western spruce budworm suppression throughout Oregon and Washington, primarily east of the Cascades. These projects varied in size from 800 acres treated for experimental use, to almost 675,000 acres were treated operationally in one year; a total of approximately 1.288 million acres were treated with B.t.k. during a 15-year period. These projects were conducted on a variety of ownerships, including several of the Forests that are being considered for this analysis. Projects were conducted on the Wallowa-Whitman, Umatilla, Malheur, and Wenatchee NF's (Ragenovich, 1988; Sheehan, 1996b). Since Douglas-fir tussock moth and western spruce budworm both use the same host species, Douglas-fir and true fir, it is very possible that many of the areas being considered for protection from Douglas-fir tussock moth have been treated at least once, and in some cases twice with B.t.k. in the past 15 years. Although the target insect in these projects was western spruce budworm, most certainly, any Douglas-fir tussock

moth in the project areas was also exposed to the B.t.k. applications. The last B.t.k. treatment on any of these Forests occurred on parts of the Umatilla and Wallowa-Whitman NF's 7 years ago, in 1992.

EFFECTIVENESS OF TREATMENT IN ACHIEVING PROJECT OBJECTIVES

It is not the intent of the proposed treatment to attempt to control the DFTM outbreak throughout the entire outbreak area. The primary project objective is to provide foliage protection and prevent tree mortality within specific areas of concern. Many areas within the outbreak area would be left untreated. Because DFTM populations build up rapidly, cause significant defoliation in a short period of time, and then quickly collapse, the window for achieving this desired protection is very narrow, and the need to provide foliage protection is limited to one or two years. To prevent damage, populations need to be detected and controlled before tree defoliation occurs. Research indicates that most tree mortality from defoliation occurs during, or is the result of the peak year of defoliation (Wickman, 1978). Although the trees are also defoliated the following year, during the decline phase, when the population is collapsing, little benefit results from preventing this additional defoliation.

The proposed insecticides are both biological. B.t.k. causes larvae to cease feeding within a day or two of ingestion. Larvae may continue to feed for slightly longer after ingesting the NPV, and the contagion effect of the virus spreading through the population may take several weeks. As a result, some defoliation can be expected the year of treatment. During a study using both B.t.k. and the virus, treated trees sustained about 15 – 22% defoliation while untreated trees had about 63% defoliation (Stelzer, et al., 1975). In 1981, Shepherd, et.al. (1984) tested a management strategy against very early first instar larvae. In this study, they achieved very little foliage protection the year of treatment, however, trees recovered quickly when populations disappeared due to the virus epizootic caused by the treatment. In another study in 1982, the application of the virus brought about the collapse of the population in the treated plots earlier than if it had been left to the naturally occurring NPV epizootic, and thus prevented tree mortality in these plots (Otvos, et.al. 1987a). Protection of foliage was negligible in year of treatment in plots treated with virus, because the virus is slower acting; however, in the following year treated plots had light tree mortality (4-7%) as compared to untreated plots that had 60-62% tree mortality. Trees sustained defoliation during the year of treatment, however, they recovered quickly when populations disappeared (Shepherd, et. al., 1984).

Treatment with either B.t.k. or TM-BioControl virus, early in the outbreak, prior to peak defoliation would achieve the project objective of protecting trees within the areas of concern until the natural collapse throughout the rest of the outbreak. Varying amounts of defoliation were observed the year of treatment based on the particular application

strategy. Some defoliation would occur within the treated areas the year of treatment. However, the quick recovery of those trees and the prevention of subsequent tree mortality would achieve the short-term objective of maintaining the current condition of those sites during the current outbreak.

There has been little work in comparing the effectiveness of B.t.k. and virus on DFTM populations. Similar results in population reductions and foliage protection were achieved in one study (Stelzer, et. al. 1975). Both insecticides appear equally effective in bringing the populations down for the year or two prior to the widespread population collapse; and the parasite and predator complex takes over and is the important factor in low-level populations.

RESURGENCE OR REINVASION FOLLOWING TREATMENT

Concern of effectiveness of treatment is based primarily on the possibility that high insect populations would return one or two years following treatment. Experience with western spruce budworm treatment projects show that large scale projects, for the most part, do not provide more than one or two years of foliage protection (Sheehan, 1996a).

In the past, most operational DFTM projects were conducted during the decline phase of the outbreak cycle of the DFTM. The virus had already established an epizootic and populations were collapsing naturally. Resurgence of the outbreak would not have occurred regardless of whether the area had been treated or not, because natural factors had already come into play. However, there are some examples and instances where treatment did take place earlier in the outbreak cycle (i.e. prior to the decline phase of the outbreak). A field experiment with acephate in 1974 resulted in good foliage protection and only a small portion of the tussock moth populations survived. This resulted in a lower amount of NPV within the treated area. However, the lowered prevalence of the NPV in the treated plots did not result in recovery of the population to outbreak size (Thompson, 1978). A project conducted in 1981 in British Columbia using Virtuss (the registered Canadian DFTM virus insecticide) was aimed at treating in an early stage of the outbreak cycle of Douglas-fir tussock moth. Populations within the treated areas decreased, while populations in the untreated checks continued to increase (Shepherd, et al. 1984). When populations collapsed, they did so throughout the outbreak area, regardless of whether or not it had been treated (Otvos, et. al., 1987b). No resurgence of an outbreak DFTM population after treatment has ever been recorded. The extended DFTM outbreak in New Mexico (Hofacker, et. al., 1979) did not resurge once it had been treated.

Douglas-fir tussock moth population outbreaks and collapses occur regardless of treatment, and, based on the information available, treatment does not prolong an insect outbreak. This is also apparently true of sustained cycle

insects, such as the western spruce budworm, as well, where insect populations collapsed throughout the outbreak area at the same time, regardless of earlier treatments in some areas within the general outbreak (Sheehan, 1996a). Climatic and environmental factors are apparently the driving factors in determining the course of the outbreak (Shepherd, 1994).

The rapidity at which the natural virus can spread throughout the population prevents opportunity for DFTM populations to rebound. Once populations are brought back down to low populations, natural parasites and predator complexes exert a significant influence on the later stages of decline, and endemic DFTM populations (Mason, et.al. 1983; Torgersen, personal communication).

Since the female Douglas-fir tussock moth does not fly, dispersion is limited to movement of the early instar larvae on the wind. However, these larvae do not disperse in high enough numbers to create a new outbreak center before the outbreak collapses (Wickman, et. al., 1973). Therefore, insects do not reinvade treated areas from adjacent untreated areas.

EFFECTS ON THE NATURAL PREDATORS AND PARASITES

Disruptions of non-target organism populations are of concern when evaluating any alternative control method. Parasites of sustained or long cycle insects such as the western spruce budworm respond to their hosts in a delayed manner and would be more unlikely to respond to any rapid changes brought about by man or nature (Hamel, 1977), than parasitoids of a fast cycle insect.

The parasite and predator complexes of DFTM are extremely efficient in locating and maintaining the DFTM populations at low levels. DFTM populations experience a rapid build-up of numbers, and then total collapse of the population within a short period of time, and their parasites simply cannot respond numerically to this type of cycle. Where they are most effective is in maintaining low numbers of the host for long periods of time between outbreaks, and in the collapse phase. The parasites respond somewhat to the increased host densities so they can take advantage of the reduced host numbers brought about by the virus (Torgersen, personal communication). TM BioControl would not directly affect the parasites because it is species specific to the tussock moth. Also, it does not disrupt the parasites to any greater extent than a natural virus event. Treatment with TM BioControl should not affect the natural parasite and predator complex.

The objective of treating with B.t.k. would be the same, to bring DFTM populations back down to low levels. Once these populations are at reduced levels, whether because of natural virus or other means such as weather, or B.t.k., the complex of predators and parasites would exert their influences.

Little work has been done on the effects of B.t.k. on the DFTM parasites and predators. Parasites that would be most likely to be affected by an insecticide application

would be those that infect the larval stage. Of eleven species of parasites recovered from western spruce budworm larvae, two species, *Apanteles fumiferanae* and *Glypta fumiferanae*, accounted for over 90% of the parasitism. Only 37 of the 3000 parasites recovered contained Bt spores and crystals. These parasites emerged sufficiently to exit their hosts but were not able to complete development. However, it could not be determined whether the cause was due to microbial infection or insufficient nutrition because of early death of the host (Niwa, 1987). Studies of effects of Bt parasites of western spruce budworm report either alteration in abundance of parasites (i.e. there increases in some parasites and decreases in others) (Hamel, 1977), or there was no significant effect on the overall parasite complex (Buckner, et. al. 1974, cited in the GM EIS, 1995; Niwa, 1987). Effects of B.t.k. on parasites of gypsy moth are reviewed in the Gypsy Moth EIS (1995). Some studies found no change in rates of parasitism by most species due to application of B.t.k. A number of others found increased rates of parasitism and survival of parasites because the B.t.k. prolonged the rate of development of the host caterpillar (cited in Gypsy Moth EIS, 1995).

Pheromone applications aimed at reducing DFTM populations through mating disruption did not result in reduced parasitism of fertile egg masses by *Telenomus californicus* (Sower and Torgersen, 1979).

The primary parasites and predators of DFTM are the egg parasite, *Telenomus californicus*, and avian predators. It is unlikely that treatments with either TM-BIOCONTROL or B.t.k. would affect these, or any of the parasite/predator complexes of DFTM to any significant degree, if at all.

As the virus epizootic runs its course, the infected later instar larvae serve as the primary means for returning the NPV back into the soil in the area. Early instar larvae that die from virus infection remain stuck to the foliage, where the NPV can readily infect other larvae. The greatest effect of applied control, whether with the virus or other insecticides, is to reduce the tussock moth populations so much that the NPV epizootic develops much more slowly or is prevented (Thompson, 1978). This results in reduced amount of virus in the forest ecosystem. The virus produced in early larval instars is largely inactivated on the foliage, presumably, by solar radiation and never becomes incorporated into the soil. A much larger percentage of NPV is produced in the older larvae (Thompson and Scott, 1979). Treatment with the virus or other insecticides, applied before an epizootic has developed, would result in reduced NPV in the forest ecosystem (Thompson, 1978). Whether this reduction is significant, is not known. The virus, once in the soil is extremely persistent; and apparently extremely small amounts are required to initiate an epizootic. The virus appears to be efficiently moved and distributed throughout the forest environment. Outbreaks that occur in areas where there has been no known previous outbreak, still collapse from a virus epizootic. Not all spray drops would impinge on a foliage surface, therefore in TM BioControl applications,

presumably some virus would be returned directly to the forest floor, although not in the concentrations that would occur in a natural epizootic. Insecticide treatments may cause a reduction in the virus in a localized area; but these impacts may not be comparable to those reductions caused by other disturbance factors. Adjacent untreated areas would serve as a reservoir for initiating future virus epizootics, and treatment would not eliminate the virus from the forest system. The No Action Alternative would not result in any impact to the natural virus in the ecosystem; it is likely that there would be some reduction of virus in the forest ecosystem with all three Action Alternatives. It is not believed that this reduction would be significant however additional research or monitoring would be needed in this area.

LONG-TERM RESISTANCE OF THE INSECT TO INSECTICIDE

B.t.k.

There is a question regarding the potential build up of resistance in a population through repeated exposure to an insecticide. Douglas-fir tussock moth, in some of the proposed treated areas would have been exposed to one, and possibly two previous treatments with B.t.k in the last 15 years. Resistance is developed by genetic selection against susceptible individuals in a population. Studies, under field and laboratory conditions, have shown that the diamondback moth, and other agricultural insects, such as the Indian-meal moth and tobacco budworm, can develop significant resistance through repeated exposure to B.t.k (Tabashnik, et. al., 1990; Tabashnik, et. al., 1991); and in laboratory tests 5 of 10 different moth species developed more than 10-fold resistance after selection for 7-23 generations (Tabashnik, 1994). The tests with diamondback moth did show that the resistance was recessive (Tabashnik, et. al., 1992). Tests for resistance in the diamondback moth are rigorous (i.e. repeated exposures; up to 5 treatments 4-5 days apart, and for repeated generations) (Tabashnik, et. al. 1991). Variability in resistance of gypsy moth suggested the potential for resistance development through natural selection (Rossiter, et. al., 1990). Resistance can be slowed, however, by integrating the use of B.t.k with natural parasites and predators Chilcutt and Tabashnik, 1999).

It is very unlikely that resistance to B.t.k would build up in the tussock moth populations based on a variety of reasons. B.t.k has little direct effect on the natural enemies; development of those individuals that do not receive a lethal dose of B.t.k is extended, thereby allowing them more exposure to natural parasites and subsequently being removed from the population. Forest insect populations may be exposed to a B.t.k treatment once every 7 or 8 years, or even longer, on an average. Infrequent applications are not conducive to development of resistance. Genetic mixing with untreated populations during intervening years would result in any expression of resistance remaining in the background. Refuges of

untreated areas, or areas treated with virus would allow genetic variability in the populations.

TM-BioControl

This insecticide is comprised of the natural virus of the DFTM. Complete resistance of tussock moth to the virus has not been found, either in extensive laboratory rearing or in field populations, although field populations are generally heterogeneous in susceptibility. No increase in resistance to infection was found in an outbreak occurring after the NP-caused collapse of an outbreak at the same location in Idaho (Thompson, 1978). It has been proposed that resistance to an epizootic in an insect population is not easily established. By the time an epizootic has run its course, the surviving insects have usually completed their metamorphosis, migrated, or died from other causes, and a new, non-immune population has arisen. The influence of any immune survivors that persisted may fade into insignificance (Steinhaus, cited in Thompson, 1978). The treatment using TM BioControl proposes to introduce higher levels of the virus into the populations, one-two years earlier, than would naturally occur. If there were any resistance or natural selection for resistance against this virus it would occur in response to the natural virus build up as well, if the areas were to be left untreated.

NO ACTION ALTERNATIVE

No treatment would be done under this alternative. Outbreaks would be allowed to continue under natural conditions. Treatment effectiveness, resurgence and reinvasion, and impacts on predators and parasites would not be an issue. The highest amounts of natural virus would return the forest ecosystem to normal levels under this alternative. Development of resistance to the virus, if it did occur, would be natural. There would be no opportunity for developing resistance to *Btk*, and it would continue to increase the amount of time since the last exposure of the insects to this insecticide.

PROPOSED ACTION

This alternative would treat selected areas of concern. All other infested areas would remain untreated. The treatments, either with TM-BioControl or B.t.k would be effective in reducing those populations within the treated areas and providing foliage protection and preventing tree mortality for the duration of the outbreak. Since the outbreak cycle is very short, only one or two years of foliage protection is required. Because of the short outbreak cycle and the fact that the female does not fly, there would be no opportunity for reinvasion into the treated area. There would be no impact on predators and parasites since their role in the DFTM population cycles are to maintain the populations during declining and endemic populations. The natural virus exists in the soil for decades between outbreaks and most virus is returned to the soil through the larger infected larvae. During treatment with either B.t.k or TM-BioControl, most larvae that die would be the younger larvae, and less virus would be returned to the ecosystem. What the very long-term

impact of localized reductions in virus in the forest ecosystem would be is unknown, however, since there would still be untreated areas throughout the forests that would allow development and return of virus to the forest floor, it would still be present in the overall ecosystem. Resistance to TM-BioControl is not likely, or if it occurs it would be no different than would occur under untreated conditions. Resistance to B.t.k is not likely because of extended periods of time between exposure to B.t.k and since there would be refuges of untreated insects in adjacent areas, and areas throughout the forests that would allow for genetic mixing.

EXPANDED PROTECTION ALTERNATIVE

In this alternative, the selected areas of concern plus additional areas with 60-100% host type would be treated. As with the Proposed Alternative, treatments, either with TM-BioControl or B.t.k would be effective in reducing those populations within the treated areas and providing foliage protection and preventing tree mortality for the duration of the outbreak. Since the outbreak cycle is very short, only one or two years of foliage protection is required. Because of the short outbreak cycle and the fact that the female does not fly, there would be not opportunity for reinvasion into the treated area. There would be no impact on predators and parasites since their role in the DFTM population cycles are to maintain the populations during declining and endemic populations. The natural virus exists in the soil for decades between outbreaks and most virus is returned to the soil through the larger infected larvae. During treatment with either Btk or TM-BioControl most larvae that die would be the younger larvae, and less virus would be returned to the ecosystem. More areas and acres would be treated in this alternative, so overall; there would be fewer viruses returned to the soil in the treated areas. What the very long-term impact of localized reductions in virus in the forest ecosystem would be is unknown. There would still be untreated areas throughout the forests that would allow development and return of virus to the forest floor, it would still be present

in the overall ecosystem, however in less amounts than with the Proposed Alternative. Resistance to TM-BioControl is not likely, or if it occurs it would be no different than would occur under untreated conditions. More acres would be treated with Btk, however, resistance to Btk is not still likely because of extended periods of time between exposure to Btk, and since there would still be refuges of untreated insects in adjacent areas, and areas throughout the forests that would allow for genetic mixing.

TM-BIOCONTROL ONLY ALTERNATIVE

This alternative would treat selected areas of concern with TM-BioControl only. All other infested areas would remain untreated. It would be effective in reducing those populations within the treated areas and providing foliage protection and preventing tree mortality for the duration of the outbreak. Since the outbreak cycle is very short, only one or two years of foliage protection is required. Because of the short outbreak cycle and the fact that the female does not fly, there would be not opportunity for reinvasion into the treated area. There would be no impact on predators and parasites since their role in the DFTM population cycles are to maintain the populations during declining and endemic populations. The natural virus exists in the soil for decades between outbreaks and most virus is returned to the soil through the larger infected larvae. During treatment with TM-BioControl most larvae that die would be the younger larvae, and less virus would be returned to the ecosystem. What the very long-term impact of localized reductions in virus in the forest ecosystem would be is unknown, however, since there would still be untreated areas throughout the forests that would allow development and return of virus to the forest floor, it would still be present in the overall ecosystem. Resistance to TM-BioControl is not likely, or if it occurs it would be no different than would occur under untreated conditions.

Table B-1: Summary of Treatment Effects on Douglas-fir Tussock Moth

	NO ACTION ALT.	PROPOSED ACTION	EXPANDED PROTECTION ALT.	TM-BIOCONTROL ONLY ALT.
Treatment effectiveness	None	High	High	High
Chance of resurgence or reinvasion	None	None	None	None
Impact on predators and parasites	None	None	None	None
Impact on natural virus	None	Unknown	Unknown	Unknown
Resistance to B.t.k.	None	None	Very Low	None
Resistance to virus	None	None	None	None

APPENDIX C: PUBLIC INVOLVEMENT

INTRODUCTION

The overall goal for public involvement was to provide an "open process" that involved people as early as possible. This meant reaching out to a wide spectrum of the public within two states interested in the management of lands administered by the USDA Forest Service. Additionally, it meant showing how public input was used in the development of this DEIS.

PLANNING

Because of the trapping program of 1998, scientists are anticipating outbreak populations in the spring of the year 2000. Once it was known that an outbreak was imminent, the Forest Supervisors of the affected Forests and the Regional Forester held several meetings to decide a course of action to deal with this pest. The outcome of these meetings was the basis for the scope of this document as well as the basis for the proposed action. Additionally, due to the tight time frame, a decision was made to write an EIS considering only Forest Service lands and not adjacent lands. Another outcome of these meetings was the decision to complete one document for the Region rather than attempting to complete nine separate documents, one for each Forest.

SCOPING

Scoping is a process required in the early stages of preparing an EIS (40 CFR 1501.7). This process is used to determine the scope of the issues to be addressed and for identifying the significant issues related to the proposed action. The significant issues are then used to generate a full range of alternatives based on the proposed action. As part of the scoping process, a Notice of Intent was published in the Federal Register on June 18, 1999. This notice described the intention of the Forest Service to manage the anticipated tussock moth outbreak in Oregon and Washington. A 30-day comment period ended in July. No comments were received by the Forests or the Regional Office.

Meanwhile, an Interdisciplinary Team developed a "scoping" package that contained a letter of introduction describing the pending problem and a description of the proposed action. A self-addressed letter asked four questions to which interested participants were asked to respond. Each Forest was asked to attach specific information about the tussock moth outbreak. Packages were mailed July 1999. The team accepted comment letters until September 1, 1999. This deadline was necessary to finalize the significant issues and concerns, and to develop alternatives. Nine additional comment forms and letters were received after the September deadline.

ALL comments were analyzed as to whether it contained significant issues, concerns, or general comments. If more than one letter contained a comment with the same theme, the comments were combined to form a specific issue/concern. The Regional Office does not keep a record of individual mailing lists maintained by each Forest. Interested parties should contact the specific Forest(s) for that information.

Table C-1: Comments Received

Forest	Letters	Internet	Phone
Colville	6		
Fremont	2		
Malheur	18		
Ochoco	30		
Okanogan	5		
Umatilla	10		
Wallowa-Whitman	12		
Wenatchee	23		
Winema	4		
Unknown Forest	28		
Total	138 + 9 late = 147	1	6

Table C-2: Comments by Affiliation

Affiliation	Comments
No affiliation noted	73
Adjacent landowner/permittee/rancher/farmer	20
Timber industry/forestry consultant	17
Environmental organization	12
Chamber of Commerce or municipality	5
Federal or State agency	5
Recreation user group/organization	4
Organized camp/recreation retreat	2
Retired Forest Service employee	2
Miner	1

RESPONSE FORM QUESTIONS

1. *What are the resource (wildlife, recreation, and other) values/issues that you think should be considered in the EIS?*

- (39 respondents): The Forest Service should consider "timber values and forest health" with most respondents favoring a spray project to protect these values.
- (15 respondents): The Forest Service should consider "multiple uses and multiple resources" in the EIS.

¹ A few respondents wrote letters concerning separate Forests or wrote on behalf of someone else.

- (4 respondents): The Forest Service should consider “scenic” resource values in the EIS. One respondent was concerned about effects to scenery in Wilderness areas.
- (35 respondents): The Forest Service needs to consider “wildlife values” and expressed specific concerns for both the initial and residual effects of this project on non-target species and their habitat including T & E species and late successional habitat.
- (18 respondents): Impacts on recreation should be considered in the EIS.
- (5 respondents): The EIS should consider “fire hazard” caused by mortality of infested trees.
- (5 respondents): The EIS should consider “water quality” including the effects to domestic water supplies.
- (4 respondents): The EIS should consider “additional research” relative to the treatment agents proposed for use.
- (3 respondents): The EIS should consider the effects of spraying in Wilderness areas.
- (1 respondent): Concern over the Little Pend Oreille National Wildlife Refuge and the effects created by the tussock moth. Interested in controlling the tussock moth if it is a threat in the refuge.

2. Are there sites of particular concern to be treated? Not treated? Why?

- (33 respondents): Support for treating infested areas identified in the National Forest mailings.
- (30 respondents): These respondents listed specific areas on National Forests that should or should not be sprayed.
- (18 respondents): Noted adjacent ownerships where treatment should or should not occur. Note: Of the 18, one respondent opposed spraying adjacent to their land and garden areas. Another respondent who represented Crater Lake National Park felt their participation was unnecessary due to low risks of outbreak.
- (8 respondents): Concerns for treatment within “old growth” areas and near “fisheries”. Two wanted the Forest Service to show restraint in treatment “tread softly” while most favored treatment to avoid defoliation.
- (7 respondents commented): Spraying should be done in areas important to timber production.
- (3 respondents): Concerned about spraying near populated areas such as nearby villages, organized camps, and domestic water supplies.
- (4 respondents): Concern about spraying in Wilderness. Reference was made to the fact that the moth is a natural part of wilderness. Additionally,

Hell’s Canyon National Recreation Area is a unique ecosystem and should be handled with a stricter standard.

- (1 respondent): Opposed to spraying in any areas particularly around this person’s residence on the Umatilla National Forest.
 - (1 respondent): All areas on the Malheur should be treated.
 - (1 respondent): Challenged the viability of the spray project on the Malheur, Umatilla, Wallowa-Whitman, and Ochoco on concerns of efficacy of the treatment, tree mortality impacts on the environment, or the unknown cost/benefit ration of the project.
- 3. What are other issues (social, economic, and other) that you would like to see addressed in the analysis?*
- (50 respondents): There is a need to address social and economic issues in the EIS. The majority was specific to the economic benefits to local communities resulting from protection of valuable timber resources from defoliation as well as salvage activities of mortality.
 - (13 respondents): The need to address the issue of “humans”. Specifically, health issues associated with spraying.
 - (8 respondents): Concern over adjacent land ownership, specifically being able to participate, and the concern that pests and noxious weeds from public lands have invaded their property. One was response was specific about summer homes.
 - (5 respondents): The timber and resource values should be protected for future generations.
 - (4 respondents): The EIS should analyze the impacts of “not spraying”. Consider past outbreaks.
 - (1 respondent): Wanted local participation in whatever is done.
 - (1 respondent): A concern about public access to National Forests and mineral rights.
 - (1 respondent): Concerned about being informed when spraying would happen and where it would happen.
- 4. Other Comments or concerns?*
- (37 respondents): These participants chose this space to express their support for implementation of a spray project to protect forest resources.
 - (13 respondents): These participants asked specific questions about treatment method and availability of control substances.
 - (12 respondents): Made comments on administrative aspects of the projects or asked for additional information.

- (10 respondents): Three management schemes were suggested: a) Institute an aggressive salvage program of timber killed by the moth, b) Thin infested stands as a means to improve forest health and provide resistance to future outbreaks, and c) Use under-burning as a tool.
- (8 respondents): Wanted to be informed of when and where spraying was to take place.
- (8 respondents): Voiced their perceptions about past management practices contributed to this outbreak and the present unsustainable condition of the forests.
- (6 respondents): On the value of the tussock moth as a natural, native species.
- (6 respondents): Gave suggestions on other alternatives to be explored.
- (4 respondents): Chose to use this space to share thoughts on resource issues not necessarily related to spraying.
- (2 respondents): Requested additional scientific information relating to the "early warning" system and the life cycle of the moth.
- (3 respondents): Expressed concern related to the large area to be treated. One suggested quick action in the years 2000 and 2001. Another wanted to know how the effectiveness would be determined and the EIS should have a comprehensive monitoring plan.
- (2 respondents): Made comments relative to "dry site" management. These were in regards to spending money to spray versus not spraying. The other was an assessment of using fire instead of spraying to control the insect populations much like the Wenatchee National Forest "dry site" management plan.
- (1 respondent): Voiced a concern that insects would gain a resistance to insecticides if enough of it is used over time.

OTHER MEANS OF COMMUNICATION

From the beginning, newspaper articles have appeared in different regions of Oregon. These papers included *The Blue Mountain Eagle* (John Day, Oregon, June 30 and July 27, 1999), *The Bend Bulletin* (Bend, Oregon, August 3, 1999), *The Baker City Herald* (Baker City, Oregon, August 10, 1999), *The Walla Walla Union Bulletin* (Walla Walla, Washington, August 16, 1999), *The Oregonian* (Portland, Oregon, August 11, 1999), and *The LaGrande Observer* (LaGrande, Oregon, August 5 and 11, 1999). Readers were informed of the potential tussock moth outbreak and the potential for defoliation over a wide area. They were informed of the availability of the Notice of Intent and whom to contact. The *Walla Walla Bulletin* interviewed a Forest Service entomologist on the tussock moth interdisciplinary team.

This Forest Service entomologist was also interviewed by *Oregon Public Broadcasting* and *KPLU*, Seattle Washington.

An article on the possible tussock moth outbreak appeared in the *Weekly Member Update* published and distributed by the Prineville-Crook County Chamber of Commerce on August 2, 1999.

The Forest Service maintains an Internet site where users can view information on various projects and items of interest. The Regional Office also offers a web page specific to the tussock moth: www.fs.fed.us/r6/nr/fid/eisweb/dftm_eis.htm. This site features regular updates on the progress of the analysis and other general information.

MAILINGS

The DEIS has been mailed to numerous agencies, organizations, and individuals. Please refer to Chapter V for a list of interested respondents.

RESPONSE TO COMMENTS

A table summarizing comments on the Draft Environmental Impact Statement follows. The table also contains references to how these comments are addressed in the Final EIS.

Table C-3: Response to Comments

COMMENT (# RECEIVED)	REFERENCE	RESPONSE
Do research results exist from the last DFTM spray project(s)? (1)		No research was conducted in conjunction with the 1991 DFTM outbreak. Although not necessarily in conjunction with the suppression project, a significant amount of research was done on DFTM during the 1972-74 outbreak and after. This information is reported in numerous publication and articles – many are referenced throughout this EIS
Show effects of the 1972 outbreak and show maps (1)		Effects of the 1972-74 outbreak are not displayed, but information from that outbreak was used and referenced throughout the document – such as acres of defoliation, estimated mortality by defoliation class, and subsequent bark beetle mortality.
Address Economics / cost benefit analysis (3)	Ch. IV, Cost of Operations	
Discuss funding availability (1)		Funding for potential large scale insect suppression projects are outside of the USFS base budget and requested annually as a separate request from the Sec. of Agriculture and/or Congress.
What is the cause of the outbreak of tussock moth (1)	Ch. III, Douglas-fir Tussock Moth	
Should wait to treat until it's known if the tussock moth population collapses (1)	Ch. III, Douglas-fir Tussock Moth; Appendix D	Douglas-fir tussock moth outbreaks typically build fast and then they collapse within 2-3 years. However, by the time the population collapses, the damage is done – this project is intended to prevent the damage (defoliation) before the collapse. That means the population needs to be checked before it has a chance to incur damage.
Discuss native predators and parasites of the Doug-fir tussock moth (1)	Ch. III, Douglas-fir Tussock Moth; Ch. IV, Lepidoptera: Douglas-fir Tussock Moth Appendix D	
Will the Doug-fir tussock moth rebound to even higher population levels after treatment (4)	Ch. IV, Lepidoptera: Douglas-fir Tussock Moth Appendix D	
Will the tussock moth outbreak spread between federal lands and other ownerships (1)	Ch. IV, Other Concerns: Effects on Adjacent lands; Ch. IV, Lepidoptera: Douglas-fir Tussock Moth Appendix D	
Need discussion of the beneficial aspects of an outbreak (12)	Ch. III, Forest Health Ch. IV, Forest Health Ch. III, Douglas-fir Tussock Moth	Incorporated references to Wickman et al 1986 & Wickman & Starr 1990
Need to prevent large scale damage – forests are now far from healthy (10)	Ch. IV, Forest Health	

COMMENT (# RECEIVED)	REFERENCE	RESPONSE
Need info about species composition of protected areas to evaluate beneficial effects of the No Action alternative (1)	Ch. III, Forest Health	Describes plant assn. series, % host type, structure
Discuss the relationship to bark beetle attack. [One comment specific to Tiger Canyon] – then linkage to fire (3)	Ch. III, Areas Currently Protected from Bark Beetles Ch. III, Fire Ch. IV, Issue 11- Secondary Mortality from Bark Beetles Ch. IV, Fire Ch. IV, Human Environment: Municipal Watersheds	
Role of moth in maintaining a healthy pine forest. One commenter felt that the tussock moth defoliation would help convert to pine forests, the other felt it would not (2)	Ch. III, Forest Health Ch. III, Fire Ch. IV, Forest Health Ch. IV, Fire	Incorporated references to Wickman et al 1986 & Wickman & Starr 1990
If the intent is to convert to pine, this needs a forest plan amendment (1)	Ch. III, Forest Health Ch. III, Forest Environment: OG/LOS Ch. IV, Forest Health Ch. IV, Forest Environment: OG/LOS	See Wickman et al 1986. Pine is native to these sites. All alternatives allow the outbreak to take its natural course in some areas in host type. This may result in some transition to a different plant/tree composition in stands. A forest plan amendment is not required in this case.
Need better definitions and location information on OG (1)	Ch. III, Forest Environment: OG/LOS	
Disclose effects of fuel buildup and fire risk (2)	Ch. III, Fire Ch. IV, Fire	
Check snag fall rate accuracy (1)	Analysis file, Fire	Incorporate by reference
Address changes in fire/flood cycles (3)	Ch. IV, Fire	Discussion on effects and fire are included. Effects of this outbreak on 100-500 year floods are beyond the scope of this analysis
Address human health effects from the spray (2)	Ch. IV, Human Environment: Health; Appendix H	
Should there be a concern of human health effects from tussockosis (1)	Ch. IV, Human Environment: Health Appendix H	
Obtain approval from the WA Dept of Health (1)		An approval is not required in this case, but it is our intent to work with state agencies on projects of this nature. They have submitted an opinion saying that they expect no adverse public health impact from the proposed methods of controlling tussock moth.
Non-target Species. Concerned about B.t.k. wiping out other Lepidoptera species. (Include Dr. Miller study on topic in LaGrande) (20)	Ch. III, Lepidoptera Ch. IV, Lepidoptera: Non-Target Analysis file: Non-Target Lepidoptera;	Dr. Miller has not done work in LaGrande (pers. com.). However, all three of Dr. Miller's studies on non-targets, in addition to other non-target Lepidoptera studies by Grimbale, Sample, Peacock, Wagner, and Hall were cited and used extensively in the analysis

COMMENT (# RECEIVED)	REFERENCE	RESPONSE
Concern about non-target invertebrates (2)	Ch. III, Fish & Wildlife Ch. IV, Fish & Wildlife: Sensitive Species Ch. IV, Fish & Wildlife: Other Species	
Concern about the sufficiency of research of B.t.k. on other than non-target Lepidoptera such as DFTM predators and parasites (2)	Ch. IV, Lepidoptera; Douglas-fir tussock moth Appendix B Appendix E	
Why are non-target lepidoptera populations expected to recover in a couple of years and not the tussock moth (1)	Ch. IV, Lepidoptera: Douglas-fir Tussock Moth Appendix B Appendix E	Both the non-target Lepidoptera and the tussock moth do recover. The treatment will bring the extremely high Douglas-fir tussock moth outbreak levels back down to endemic levels. The tussock moth is not eliminated, and it does recover to normal population levels. Its normal level is very low. It will just not return to outbreak levels.
B.t.k. may drive fragile T&E moths and butterflies to extinction (4)	Ch. III, Lepidoptera; Ch. IV, Lepidoptera: Non-Target Analysis file: Non-Target Lepidoptera Analysis file: Non-Target Lepidoptera	
EPA data shows that side effect using B.t.k. is large reduction of animal biomass (2)		The EPA study is not referenced, but Dr. Miller's work is referenced. It presents similar results regarding reductions of biomass.
Should not conclude that uncertain effects of TM-BioControl on non-target Lepidoptera is equivalent to no effect (1)	Ch. IV, Lepidoptera: Non-Target Ch. IV, Issue 3: Effects on Non-Target Lepidoptera	TM-BioControl is specific to Douglas-fir tussock moth and 3 other species of tussock moths.
Concern about 9 rare Lepidoptera species (1)	Ch. III, Lepidoptera Ch. IV, Lepidoptera: Non-Targets Analysis file: Non-Target Lepidoptera	
Address effect of spray on reducing food source for birds and other species (7)	Ch. III, Fish & Wildlife Ch. IV, Fish & Wildlife: Sensitive Species Ch. IV, Fish & Wildlife: Other Species	
Discuss Army cutworm as food source to bears, wolverines and other predators (3)	Ch. III, Fish & Wildlife Ch. IV: Fish & Wildlife: Other T&E Species Ch. IV, Fish & Wildlife: Sensitive Species Ch. IV, Fish & Wildlife: Other Species	
Describe cumulative impacts from spraying on croplands, other forestlands (2)	Ch. IV, Other Concerns: Cumulative Effects of Treatment	
Address indicator butterflies in ICBEMP (1)		There are no plans to use butterflies as indicator species in ICBEMP
Avoid spraying meadows, marshes and forest edges (1)	Ch. II, Mitigation Measures Appendix G: Operations Guidelines	

COMMENT (# RECEIVED)	REFERENCE	RESPONSE
Address Johnson's Hairstreak (1)	Ch. III, Lepidoptera Analysis file: Non-Target Lepidoptera	
Conduct surveys for 159 rare lepidopteron species and 114 species of uncommon lepidopteron species (1)	Ch III Lepidoptera Ch. IV, Lepidoptera: Non-Targets Analysis file: Non-Target Lepidoptera	The analysis addresses threatened & endangered listed species & candidates for listing, and Forest Service sensitive species list. State lists and other reports and lists of species were examined and addressed where appropriate. The analysis addresses risks to these species. With that and additional mitigation measures, surveys are not necessary.
Should take a baseline survey before/after treatment	Ch III Lepidoptera Ch. IV, Lepidoptera: Non-Targets Analysis file: Non-Target Lepidoptera	See the response above. In addition, studies were referenced that tracked Lepidoptera populations before and after previous spray applications.
Do surveys exist on T&E or sensitive lepidoptera, or predators (1)	Ch. III, Lepidoptera Ch. IV, Non-Target Lepidoptera	Since no T&E Lepidoptera species occur on the Forests in the analysis; no surveys have been conducted; mitigation measures will favor sensitive species.
Address Lepidoptera species in riparian habitat (2)	Ch. III, Lepidoptera Ch. IV, Lepidoptera: Non-target	Riparian species were not addressed, per se. Rather, non-target Lepidoptera in various habitats were addressed as a whole.
Utilize information from the Rare Butterfly study by Paul Hammond and others including works by Grimbale, Beckwith, Hammond (1)	Ch. III, Lepidoptera Ch. IV, Lepidoptera: Non-target	Hammond's Rare Butterfly Study was not used. Other sources were used and referenced, including the original report by Grimbale, on which the Grimbale, Beckwith, and Hammond study is based.
Address concerns of insecticides on culturally significant plants - impacts on humans. (1)	Ch. IV, Human Environment: Health; Appendix H	
Discuss the mardon skipper (3)	Ch. III, Lepidoptera Ch. IV, Lepidoptera: Non-targets Analysis file: Non-Target Lepidoptera Appendix I	
Need well-designed monitoring program to determine after effects of intervention [by spraying]. Document effects on non-target species (3)		The reference provides guidelines for monitoring. Monitoring will be done to determine effectiveness in meeting objectives
Include a control area to compare with a spray area (2)	Ch. IV, Forest Health	Note that all alternatives would leave some untreated areas.
Will treatment be decided locally within protected areas (1)		The Record of Decision (ROS) will describe selected alternative to be implemented
Use TM-BioControl versus B.t.k. (5)	Ch. II, Alternatives	A TM-BioControl Only Alternative was added and considered in the analysis as a result of public comments
Analyze a bull trout and high use recreation only alternative (1)	Ch. I, Purpose and Need Ch. I Decisions to be Made	The EIS analysis addressed objectives described in the purpose and need. However, the deciding official can modify an action alternative in the decision.

COMMENT (# RECEIVED)	REFERENCE	RESPONSE
Protect fish streams only (1)	Ch. I, Purpose and Need Ch. I Decisions to be Made	See the above response
Allow for multiple treatments – logging and thinning – other (2)	Ch. II, Alts. Considered but Eliminated...	
Are successive treatments necessary (1)	Ch. III, Douglas-fir Tussock Moth. Ch. IV, Lepidoptera: Douglas-fir Tussock Moth	Successive treatments in the same area will not be necessary.
Need statement should be rewritten to look at pro's & con's of treating (4)	Ch. IV, Effects Analysis	This is analyzed in effects; not part of purpose & need
Discuss need to spray wilderness and roadless areas (1)	Ch. II, Proposed Action Ch. IV, Other Concerns: Wilderness	Roadless was not an area of concern of itself. Wilderness is addressed separately.
What "elements" were used to make up "high value" areas (1)	Ch. I Purpose and Need	
The Proposed Action does not minimize threats from bark beetle & fire from adjacent ownerships (1)	Ch. IV, Issue 11: Secondary Mortality from Bark Beetles	Areas of Concern plus high-risk areas are included in the action alternatives. Treatment will not minimize threats from adjacent lands, but will keep trees from being stressed from defoliation, so they will not be as susceptible to bark beetle attack.
Include wilderness for protection (1)	Ch. II, Proposed Action	Lake Chelan/Sawtooth for fire risk & NF Umatilla for fish habitat
Do not treat in Research Natural areas (1)	Ch. II, Mitigation Measures	These are excluded
Do not treat anadromous fish areas (1)	Ch. I Decisions to be Made	The deciding official may elect to exclude areas of concern from protection
Are seed orchards covered under an Orchard EIS? (1)	Ch. IV, Seed Orchards	There is no Seed Orchard EIS
Discuss the need to treat in viewsheds (2)	Ch. IV, Human Environment: Municipal Watersheds	
Include deer and elk habitat (2)	Ch III – Fish & Wildlife	Deer & elk habitat would be included in the Expanded Protection alternative.
Include areas available for timber harvest (2)	Ch. II, Expanded Protection Alternative	The Expanded Protection Alt. Was developed after initial Public Scoping in part to address this concern.
Set traps to control the tussock moth in infested areas (1)	Ch. II, Alts. Considered but Eliminated...	The trap-out method has never been tested or used on Douglas-fir tussock moth, and the success of such a method is unlikely. Mating disruption, another method using pheromones to manipulate populations has been tested-
Select areas to treat based on risks for damage (1)	Ch I, Purpose and Need Ch. III, Forest Health Ch. IV, Forest Health Appendix K	Risk is an important component in the EIS analysis, however, it was not the primary factor in identifying areas of concern that are described in the action alternatives. The latter were selected to meet objectives described in the purpose and need.
TM-BioControl is made from genetically engineered virus (3)	Ch. I, Ch. III, Appendix B	TM-BioControl is processed from a native virus – it is not a genetically engineered product.

COMMENT (# RECEIVED)	REFERENCE	RESPONSE
Drift of spray [near wilderness] (3)	Ch. IV, Lepidoptera: Non-target Appendix G	
Operation plans should be part of the EIS (1)	Appendix G	Operations Plans are very extensive detailed documentation specific to particular areas. However, operations guidelines are established in the EIS.
Discuss spraying operation and information on confining to irregular polygons (1)	Appendix G	
Address methods for determining outbreak levels and when need to spray (5)	Ch. III, Douglas-fir Tussock Moth Appendix D	
With the early warning system, why the need for the "emergency" exemption (2)	Analysis file, letter of justification	The "Early Warning System" only provides 9 months' notice of population increase and if the decision is one of the action alternatives, the project must be implemented this season if defoliation from the tussock moth is to be prevented.
Should display the information from the early warning system (1)	Ch. III, Douglas-fir Tussock Moth	The Douglas-fir tussock moth early warning system report is not included as part of the EIS, but is available.
Post spray areas or provide other public notification (2)	Appendix G	
Address impact on pollinators and sensitive plants (3)	Ch. IV, Plants	
Address effects on the Showy Stickseed – should there be a no spray mitigation around the plant (2)	Ch. II, Mitigation Measures Ch. IV, Plants: Threatened & Endangered Species	
Discuss coordination with private landowners (2)	Ch. I, Special Mgt Considerations, Ch. II, Features Common to All Action Alts. Ch. IV Other Concerns: Effects on Adjacent Lands.	
Why the high residential & administrative site count for the Wenatchee NF (1)	Appendix J Analysis File	Wenatchee has 7 res./admin sites. The site at Fish Lake is very large (8,000 ac)
Discuss the effects to Coleoptera, Orthoptera, & Diptera species from B.t.k.		The specificity of B.t.k. to Lepidoptera is well documented. Studies on Hymenoptera, Diptera, Neuroptera, Orthoptera, Coleoptera, Hemiptera, and Araneae have shown no adverse toxic effects to these species. Incorporate by Reference – Gypsy EIS, Ecological Risk assessment
What is the impact to DFTM parasites and predators (2)	Ch. IV, Lepidoptera: Douglas-fir Tussock Moth Appendix B	
What is the B.t.k. [spray] effect on water quality for fish (2)	Ch. IV, Issue 6: Effects of Spraying on Fish and Wildlife	

COMMENT (# RECEIVED)	REFERENCE	RESPONSE
What is the B.t.k. [spray] effect on water quality and human consumption (2)	Ch. IV, Water Quality: Insecticide Effects Ch. IV, Human Environment: Health Ch. IV Issue 7: Water Quality Appendix H	
What is the impact of the spray carrier (4)	Ch. IV, Human Health Appendix H	
Is this project to use up old insecticides – what are the expiration dates for TM-BioControl and B.t.k. Are there any purchase agreements (1)		There are no expiration dates for TM-BioControl. The FS does not have any B.t.k. on hand and there are no purchase agreements in place.
Discuss diflubenzuron (Dimilin) as an effective insecticide (1)	Ch. II, Alts. Considered but Eliminated...	
Discuss spray effects to water quality for irrigation uses – effect of spray in the water on Lepidopterans in crop fields (3)	Ch. IV, Water Quality: Insecticide Effects	B.t.k. survives for a limited time in the water. Concentrations that would reach the water through aerial application, and subsequent dilution makes impacts on Lepidoptera in crop fields highly unlikely.
Avoid direct application to streams (1)		Where operationally feasible, direct application to open bodies of water will be avoided; however, one of the objectives of the purpose and need is to protect host trees that are critical to maintaining the riparian condition or habitat, and this may require treatment adjacent to and over some streams.
Address species resistance development to B.t.k. (5)	Ch. IV, Lepidoptera: Douglas-fir Tussock Moth Appendix B	
Address the persistence of TM-BioControl and B.t.k. – especially in the soil (2)	Ch. IV, Lepidoptera: Douglas-fir Tussock Moth	Natural virus from which TM-BioControl is made has been documented to persist up to 40 years in the soil. B.t.k. is also found naturally in the soil, and can persist for several months; however, insecticidal activity is greatly reduced. Repeated applications of B.t. did not result in an increased concentration of B.t. in natural soils in the field. Gypsy Moth EIS, 1995. Appendix G, Ecological Risk Assessment
Address the effect of insecticide to other wildlife (1)	Ch. III, IV, Fish Wildlife Ch. IV, Issue 6: Effects of Spraying on Fish & Wildlife	
Disclose the forest plans desired future condition in managed forest areas (1)	Ch. III, Timber Management.	Incorporate Forest Plans by reference

COMMENT (# RECEIVED)	REFERENCE	RESPONSE
Discuss the potential for salvage logging, or post outbreak management on affected lands (4)	Ch. IV, Forest Health	No plans currently in place. Salvage logging plans could only occur after an outbreak and specifics about the location and extent of mortality is known. There are strategies and plans for projects for long term restoration of elements of the forest ecosystem such as the Blue Mt. Demonstration Project, and the Interior Columbia Basin Ecosystem Management Project draft EIS.
If timber areas are protected, will timber production increase (1)	Ch. IV Issue 2: Protection of Timber Values	Expanded Alternative addresses protecting trees to prevent volume loss
Snag fall predictions need to account for size class (1)	Analysis File-Fire	Snag fall rates not included in EIS
Address mortality predicted by size class (1)	Ch. IV, Forest Health Ch. IV, Issue2: Protection of Timber Values Analysis file: Timber	The mortality analysis of timber available for harvest does take into account broad size classes in developing an estimate of mortality.
Address loss of timber volume (1)	Ch. IV, Issue2: Protection of Timber Values.	
Address timber values the same as recreation values	Ch. III, Recreation Ch. IV, Human Environment: Recreation Ch. IV, Issue 2: Protection of Timber Values	Analysis looks only at potential volume (not value) of potential timber lost.
Identify forest plan areas where wood production allowed (1)	Ch. III, Timber Management Appendix A	
The eastside screens was short-term, interim direction (1)	Ch. III, Timber Management.	Eastside Screen are still mgt. direction
Discuss effects on 303[d] listed streams and impacts on future improvements (1)	Ch. III, Water Quality Ch. IV, Water Quality	
Discuss municipal watersheds – link to water quality – Specific mention was made of the Mill Creek watershed (3)	Ch. III, Human Environment: Municipal Watersheds Ch. IV, Human Environment: Municipal Watersheds	
Discuss effects of spraying in intermittent streams during dry periods (1)	Ch. IV, Water Quality: Tussock Moth and Insecticide Effects.	No effects on water quality are expected. As a result, it is not anticipated that there would be effects on intermittent streams.
What is the impact to reptiles and amphibians (4)	Ch. III, Fish & Wildlife Ch. IV, Fish & Wildlife: Sensitive Species Ch. IV, Fish & Wildlife: Other Species	
Discuss impact to Bald Eagles (2) – include .5 mile no spray zone (1)	Ch. III, Fish & Wildlife Ch. IV, Fish & Wildlife: Other T&E Species	
Fully discuss effects to federally listed species (1)	Ch. III, Fish & Wildlife Ch. IV, Fish & Wildlife: T&E Species (all)	
Need analysis of nesting Spotted Owls [include noise effects, critical habitat units] (1)	Ch. III, Fish & Wildlife Ch. IV, Fish & Wildlife: T&E Species Incl. in Project Obj.	

COMMENT (# RECEIVED)	REFERENCE	RESPONSE
Address effects on the Canada lynx (1)	Ch. III, Fish & Wildlife Ch. IV, Fish & Wildlife: Other T&E Species	
Address effects on the gray wolf (1)	Ch. III, Fish & Wildlife Ch. IV, Fish & Wildlife: Other T&E Species	
Address effects on the Grizzly Bear (6)	Ch. III, Fish & Wildlife Ch. IV, Fish & Wildlife: Other T&E Species	
Address effects on raptors (1)	Ch. III, Fish & Wildlife Ch. IV, Fish & Wildlife: Sensitive Species Ch. IV, Fish & Wildlife: Other Species	
Address effects on bats (2) - Townsend Big Eared bat (2)	Ch. III, Fish & Wildlife Ch. IV, Fish & Wildlife: Sensitive Species	
Address effects on neo-tropical birds (1); - insectivores birds (5)	Ch. III, Fish & Wildlife Ch. IV, Fish & Wildlife: Other Species	
Address Survey and Manage species (1)	Ch. III, Fish & Wildlife Ch. III Plants Ch. IV Fish & Wildlife: Other Species	
Consult for sensitive and endangered species (1)		In process for listed, not required for sensitive
Impacts on non-endangered species - deer or elk, others (1)	Ch. III, Fish & Wildlife Ch. IV, Fish & Wildlife: Other T&E Species Ch. IV, Fish & Wildlife: Sensitive Species Ch. IV, Fish & Wildlife: Other Species	
Address flammulated owls (2)	Ch. III, Fish & Wildlife Ch. IV, Fish & Wildlife: Other Species	
Address impacts to shrews that feed on moths (2)	Ch. III, Fish & Wildlife Ch. IV, Fish & Wildlife: Other Species	
Consider effects to woodpeckers, pigmy nuthatch (1)	Ch. III, Fish & Wildlife Ch. IV, Fish & Wildlife: Other Species	
Consider effects to micro fauna and flora (2)	Ch. IV, Issue 6, Effects of spraying on fish and wildlife.	None were identified
Discuss each Bull Trout waterway proposed for spraying (2)	Ch. III, Fish & Wildlife Ch. IV, Fish & Wildlife: T&E Species Incl. in Project Obj.	
Analyze areas where negative effect would occur [from defoliation] for salmon, steelhead, and bull trout (3)	Ch. III, Fish & Wildlife Ch. IV, Fish & Wildlife: T&E Species Incl. in Project Obj Ch. IV, Fish & Wildlife: Sensitive Species	

APPENDIX D: DFTM SAMPLING AND MONITORING

GENERAL

Proposed actions and locations of where these actions take place are based on monitoring the Douglas-fir tussock moth populations. Population monitoring takes place at several levels, and it is a combination of these levels that helps us determine whether an outbreak is potentially imminent, and where it will occur. Population monitoring consists of three levels of monitoring: the Douglas-fir tussock moth early warning system, early larval and cocoon/egg mass ground sampling, and the aerial detection survey.

DFTM EARLY WARNING TRAPPING SYSTEM

BACKGROUND

Douglas-fir tussock moth, *Orgyia pseudotsugata* (McCunnough) (Lepidoptera: Lymantriidae), outbreaks in the western United States and Canada tend to be cyclic, occurring about every 9 years (Shepherd et al. 1988). In the Pacific Northwest, a Douglas-fir tussock moth population increase typically consists of four phases or years. During the first phase, the population begins to increase but remains at sub-outbreak levels. In phase II populations continue to increase above the outbreak level threshold and some defoliation is apparent. In phase III, populations are extremely high and can result in complete tree defoliation. Populations remain very high during phase IV; however population pressure and insect pathogens cause the population to collapse during this phase. Additional defoliation will be incurred during this phase prior to the collapse of the population.

Generally, land managers do not recognize the significance or the severity of a DFTM outbreak until Phase III when the first year of complete defoliation occurs. Once significant defoliation occurs it is too late to implement any management options.

The last widespread outbreak of Douglas-fir tussock moth (DFTM) in Oregon and Washington occurred in eastern and central Washington and northeastern Oregon during 1971-1974. Since that time, populations have fluctuated twice without reaching outbreak status, except in more localized areas.

THE DFTM EARLY WARNING SYSTEM

DFTM population level trends are monitored annually throughout Oregon and Washington using a plot network of approximately 405 pheromone traps. This on-going Douglas-fir Tussock Moth Early Warning System is a cooperative effort that includes the USDA Forest Service, USDI Bureau of Land Management, USDI Bureau of Indian Affairs, Oregon Department of Forestry and the Washington Department of Natural Resources. Other western Regions and States also participate in this west wide survey. The objective of the Early Warning System is to detect incipient DFTM outbreaks. When trap catches

increase to predetermined levels, additional sampling activities are initiated to further quantify population levels (Sheehan et al. 1993). The DFTM Early Warning System is intended to provide an advance warning of population changes that would indicate a potential outbreak one to two years prior to the outbreak occurring. This would allow land managers an opportunity to evaluate and implement management options before high levels of defoliation occurred.

The pheromone traps are deployed according to standardized procedures (Daterman et al. 1979) in specified trap sites in July and retrieved following moth flight in the fall. The pheromone lures contain a very low pheromone dose and are calibrated specifically to detect low populations. There are five traps per plot. The average number of moths per trap is calculated for each plot. Male DFTM are sampled annually on these permanent locations throughout eastern Oregon and Washington.

POPULATION MONITORING PROCESS

Plot trap catch averages, trends in trap catches on plots from year to year, and trap catch density patterns over larger geographic areas, are the factors considered when determining future sampling intensity and methodology. The following sequence of sampling actions is initiated when plot averages exceed predetermined threshold levels, and when the trend of trap catches is increasing.

1. Additional pheromone trap plots are established the following year in the area surrounding plots averaging 25 or more, but less than 40 moths per trap. Establishment of additional pheromone trap plots serves to increase confidence in the accuracy of pheromone trap data for detecting incipient outbreaks in a specific area.
2. Cocoon and/or larval surveys utilizing methods developed by Mason (1979) are conducted in the fall of the same year or spring of the following year in the vicinity of plots with trap catch averages exceeding 40 moths per trap, and in areas of concern. Cocoon and larval survey data provide estimates of population densities and give more accurate indications of outbreak potential and population trends than the pheromone trap data. The traps are intended to be used **only** as an early warning indicator.

The DFTM Early Warning System is **not designed or intended** to predict exactly where the defoliation will occur; areas to be sampled on the ground should be selected on the basis of the impact of DFTM defoliation on management objectives. DFTM Early Warning System traps are **not** calibrated for use during DFTM outbreaks, or to determine population levels once an outbreak has begun. As populations increase, a decline in trap catches will

typically be noted. Larval and cocoon/egg mass surveys are used to determine what the populations are doing in a particular area, once the traps have signaled a population increase.

GROUND SURVEYS

Two types of ground surveys are done, once the Early Warning System indicates an increase in populations - early instar larval sampling in the spring, and cocoon/egg mass surveys in the fall. These samples are used to verify the presence and levels of the populations.

EARLY INSTAR LARVAL SAMPLING

The procedures for the early larval sampling are slightly modified from those described by Mason (1978) and Mason and Paul (1994). These sampling procedures are used in areas where Early Warning System trap counts are high and in the areas currently being analyzed in the EIS. It is also the sampling system that will be used in the early spring to verify that suboutbreak and outbreak populations before any treatment would occur. If appropriate levels were not evident, an area would not be treated.

Lower crown beating (LCB) is a simple method of obtaining counts of Douglas-fir tussock moth. These counts can be used to index the populations that occur in the midcrown of a host tree, or they may be used to simply express population levels directly in the lower crown. The counts which are obtained by LCB may be used to calculate population densities, and can be expressed in various different units of measurement (e.g. mean number of larvae per 3-branch sample; lower crown density per 1000 sq. in. of foliage; midcrown density per 18-in. branch tip; and midcrown density per sq. meter of foliage).

Measurements of insect densities are important information for determining current population levels and trends over time, and for providing a biological basis for management decisions regarding need for suppression, monitoring, or other follow-up actions for a stand or forest.

Lower crown beating, when timed properly will normally occur sometime between mid June and mid July. Timing will depend upon elevation and current weather conditions. Thus, sampling will likely be done over several days, or perhaps over a couple of weeks, where large areas of varying elevations and aspects are to be sampled. It is important to monitor development of host and/or insect over the area to be sampled, for this reason.

At each location, 50 tussock moth host trees (white or grand fir, and Douglas-fir) with new shoots that can easily be reached from the ground, are selected. To sample the larvae, a beating cloth is held under the apical 45-cm (18-inches) of each of three branches, and each branch is rapped about a dozen times with the beating stick to dislodge the larvae from the branch. After all three branches have been "rapped," the total number of larvae is counted, and totals are recorded. This procedure is repeated on all 50 trees on the plot. A number of plots are established throughout a sample area. This number varies

on the size of the area; in larger areas it will average about 1 plot per square mile. The sampling results are summarized by consolidating the data. The mean number of larvae is then calculated to reflect number of larvae per 1000 sq. in. of a mid-crown branch. This is then used to determine the status of the mean tussock moth population for the area. The following table is used to determine population status of an area and predicted defoliation (Mason, 1978):

Average less than 3.0 larvae per 1000 sq. in. = low-level; population at least 2 years away from outbreak;

Average 3.0 - 20.0 larvae per 1000 sq. in. = suboutbreak; potentially one year away from outbreak;

Average 20.0 or more larvae per 1000 sq. in. = outbreak level

Another sequential sampling method for sub-outbreak populations is also sometimes used. It also involves lower crown beating and numbers of trees sampled is determined by the population densities; this sampling method categorizes the sampling area into L= Low; S = Sub-outbreak; and I = Indeterminate (Mason, 1978).

COCOON/EGG MASS SAMPLING

Populations are also monitored through cocoon/egg mass sampling in conducted in the fall after the adult flight. The frequency of the cocoons and egg masses can also predict the population and defoliation levels that can be expected the following spring and are based on lower crown cocoon samples (Mason, et. al., 1993). The number of sample plots per sample area is determined by the size of the sample area. Twenty-five to fifty host trees are randomly selected per plot. The undersides of three 18-inch branch tips are examined for the presence or absence of cocoons and egg masses and the total number for the three branches is recorded. The proportion of the samples infested calculated to reflect mid-crown densities, which are in turn used to estimate population levels and predicted defoliation for the following year. These densities are:

Low density; no defoliation = Less than 0.01 cocoons per 1000 sq. inches in the lower crown

Sub-outbreak, little or no visible defoliation = 0.3 cocoons per 1000 sq. inches in the lower crown

Moderate outbreak, defoliation visible on most trees = 0.31-0.70 cocoons per 1000 sq. inches in the lower crown

Severe outbreak, defoliation intense in upper crowns of many host trees with some trees completely defoliated = greater than 0.70 cocoons per 1000 sq. inches in the lower crown

AERIAL DETECTION SURVEY

In addition to the pheromone trapping and insect population monitoring on the ground Douglas-fir tussock

moth defoliation can be detected from the air. An annual aerial detection survey is conducted over all forested lands in Washington and Oregon and tree mortality and defoliation are recorded. This is also one way to monitor the progress and outcome of a Douglas-fir tussock moth outbreak. However, once defoliation is visible from the air, the populations have moved from suboutbreak to moderate outbreak levels. Generally, defoliation is expressed in a few areas one year, and then encompasses much larger areas the following year. Information from the first year when some visible defoliation is apparent can

help determine where to focus additional sampling. However, the ultimate use of the aerial survey will be to record the location, extent and severity of the outbreak as it progresses, and monitor secondary mortality from bark beetles in the area following the decline of the outbreak. The defoliation is recorded as light, moderate, and heavy defoliation and mortality in acres.

APPENDIX E: EFFECTS OF B.T.K ON NON-TARGET MOTHS AND BUTTERFLIES

SPECIES	APPLICATION RATE	SITE DESCRIPTION	RESULTS AND CONCLUSIONS	STUDY R ²	DESIGN C	STUDY
Target = spruce budworm (<i>Choristoneur fumiferana</i>)	Thuricide 16B Dipel WP, with and without chitinase. 2 & 4 lbs. /acre	Algonquin Park, Ontario, & Spruce Woods, Manitoba. Spruce-Fir forests.	Numbers of hand-picked larvae from aspen, alder, and maple were not different on control and treated plots.	No	Yes	Buckner and Others, 1974
32 species of Lepidoptera on tobacco brush, <i>Ceanothus velutinus</i>	20 BIU/ha	Estacada, Clackamas Co., Oregon Program to control spruce budworm (<i>Choristoneura occidentalis</i>)	Number of larvae on shrubs in treated site decreased 80% between pre- and post-treatment surveys compared to control site where number of larvae increased 6% in same time period, 2 weeks post-spray. 2 months post-spray there were no differences between spray and control sites. One year after spray and 1 st post-spray sample, larval abundance was lower than pre-treatment the previous year and lower than control site. Late-season sample in 2 nd year was again no different between control and treated sites. Species richness and diversity not statistically different between control and treated site; <i>B.t.k.</i> tended to even-out the proportion of species.	No	Yes	Miller, 1990a
35 spp. Lepidoptera in 10 families. 11 in Garry oak (<i>Quercus garryana</i>)	40 BIU/ha 3 times	Elmira, Lane Co., Oregon Program to manage gypsy moth	3 post-spray samples. Significant differences in caterpillar density between treated and control plots for each post-spray sample; remained significant by day 68, not by day 90. Species richness significantly lower on treated plots. Species richness and larval abundance significantly lower 1 year after spray, but not 2 years after spray. Results expected of univoltine species.	No	Yes	Miller, 1990b
Forest Lepidoptera on 30 ha plots	Thuricide 32LV 3.5 L/ha	White Mtns., NH Northern hardwoods: maple, beech, birch	Spraying in 1983 significantly reduced caterpillars relative to unsprayed plots. No differences in 1984 & 1985, because numbers were naturally low on control plots those years.	No	Yes	Rondenhouse and Holmes, 1992
Non-target moths in Asian strain of the gypsy moth eradication program area	60 BIU/ha (24 BIU/acre)	Pierce and King Counties, WA	Full-spectrum lights. 49-97% lower catches at treated sites in 1993 v. same sites in 1992; stat. significant drop. Three species (<i>Orthostia hibisci</i> , <i>Protorthodes rufula</i> , <i>Perizoma curvilinear</i>) eliminated from site? Overall, moth diversity	Yes	No	Crawford and others, 1993 Wood, 1994 (pers. comm.)

² The R column indicates whether the study design included replicates, and the C indicates controls.

SPECIES	APPLICATION RATE	SITE DESCRIPTION	RESULTS AND CONCLUSIONS	STUDY R ²	DESIGN C	STUDY
			<p>unaffected.</p> <p>Spring in 1993 was significantly cooler and wetter, Untreated sites monitored in 1993 also experienced a significant decline in populations. Author attributes this decline to effects of Btk in treated areas located 1 and 3 miles away from untreated sites. Author assumes no variables, such as weather, other than <i>Btk</i>.</p>			
Cinnabar moth	Dipel hg (0, 2, 8, 25, and 250 BIUs/ha	Laboratory study on tansy ragwort	<i>B.t.k</i> has little effect on early (1-3) instar survival, but 4 th and 5 th instars were susceptible.	Yes	Yes	James and others, 1993.
Lepidoptera on 24 20ha plots treated with <i>Btk</i>	Foray 48B 36BIU/ha (15BIU/ac)	Ridge and Valley region of eastern West Virginia	<p><i>B.t.k</i> reduced richness and abundance of non-target <i>Lepidoptera</i>. Both larval and light trap sampling for adults moths conducted. Species with early season larvae experienced greatest impact; Impacts on larvae evident year of treatment; impacts on adults not observed until one year later. Monitored impacts of gypsy moth and defoliation on non-targets. Both <i>B.t.k</i> and forest defoliation by gypsy moth larvae reduce richness and abundance of native lepidopteran.</p>	Yes	Yes	Sample and others, 1993.
Micro- and macro-lepidoptera	89 BIU/ha (36 BIU/acre) Sprayed in 1992	Rockbridge Co., VA Oak woodland, 50 acre plots	<p>Sampled in 1992 and 1993. Pre- and post (day 6 and 12) foliage samples from canopy, subcanopy, and shrub-layer show reductions in the relative abundance of 16/19 most common taxa. 12/16 were microlepidopterans. In 1992 larval abundance reduced on 3/5 <i>B.t.k.</i> sites in canopy and subcanopy. Uneven application accounted for variable effects. 2 plots consistently showed the greatest effects. Total numbers of lepidopterans on foliage were no different on treated and control sites in 1993. Microlepidoptera accounted for 95% of the individuals collected from foliage in 1992 and about 85% in 1993.</p> <p>6 of 8 most common macrolepidopteran species trapped under burlap bands were reduced by treatment. 3 of these spp. were nearly absent in treated plots (<i>Satyrium calanus</i>, <i>Malacosoma dissitria</i>, <i>Orthosia rubescens</i>). Other less common spp. appeared to be significantly less on treated plots. <i>Dasychira obliquata</i> was not affected apparently. Noctuidae also lower in 1993.</p>	Yes	Yes	Peacock and others, 1994.

SPECIES	APPLICATION RATE	SITE DESCRIPTION	RESULTS AND CONCLUSIONS	STUDY R ²	DESIGN C	STUDY
Lepidoptera Sampled in 1990-1992	14.4 BIU/ha Sprayed in 1991	Grant and Pendleton Counties, WV 50 ha plots in Oak-hickory with pine; blueberry shrub layer.	4 treatments: control; bt-sprayed without gypsy moth (GM); bt with GM; GM alone (defoliated). Foliage and blacklight (b-l) samples. Total larval abundance reduced following <i>B.t.k.</i> and GM applications in 1991. No effects of <i>B.t.k.</i> and GM on several microlepidopterans noted. Total spp. richness (SR), SR of Noctuidae, and of Geometridae reduced in <i>B.t.k.</i> plots in 1991. Residual effects noted in 1992 on Noctuidae. B-1 sampling found reductions in 1991 in abundance of total Lepidopterans, microleps., and Geometridae. Total lepidop., microleps. and noctuids were reduced in 1992. Few differences in adult Lepidoptera richness between sprayed and control plots.	Yes	Yes	Sample and others, 1995; Butler, 1995.
Lepidoptera 458 species on 4 – 16ha (40ac) plots	Thuricide 16 BIU/ac	Wallowa-Whitman and Umatilla NF- northeastern Oregon – riparian areas	Monitored treated and untreated areas for 3 years (1992-1994) with black lights to monitor adult moths for 22 weeks. Conducted larval samples for 2 years, and conducted net samples of day-flying species. A large number of species (458 samples) are resident. Most species were noctuids and geometrids. Late season fliers were more abundant on the Umatilla NF than the Wallowa-Whitman NF. There were no differences between trap catch means on sprayed vs. un-sprayed plots. No evidence in ULV data that <i>B.t.k.</i> has a measurable lasting impact on nocturnal lepidopterans. Confounding effects of weather and uneven distribution of food plants may mask differences caused by spray.	Yes	Yes	Grimble, 1995.
3 Lepidoptera 2-tree feeding swallowtail butterflies, and promethia moth	Foray 48B 40 BIU/ha (16 BIU/ac.) ground application	Applications to individual trees of 7 host tree species. 4 sites in Michigan	<i>B.t.k.</i> was toxic to early and later (4 th) instar larvae regardless of host. Long-term persistence was monitored for 40 days. Toxicity for one species persisted for 30 days after treatment.	Yes	Yes	Johnson and others, 1995.
Approx. 498 species of Lepidoptera larvae	Bt at 24 BIU/ac	Warm Springs, Or east slope of central Cascade Mt. On ocean spray, snowbush and	Larval sampling and black light trapping of adult moths in treated and untreated areas. There were significant reductions in larvae species richness and abundance and biomass following treatment in 1993, with recovery of some species richness and	Yes	Yes	Miller, 1995

SPECIES	APPLICATION RATE	SITE DESCRIPTION	RESULTS AND CONCLUSIONS	STUDY R ²	DESIGN C	STUDY
		greenleaf manzanita in coniferous forests	some abundance and biomass in 1994, and no significant difference in richness, abundance and biomass by 1995. Adult trapping had a significant reduction in the numbers of adult moths trapped the fall following treatment. In 1994 the treated plot had a significantly higher number of adults trapped than untreated; and in 1995 there was no difference.			
Native non-target Lepidoptera	90 BIU/ha Single application	Goshan wildlife Mgmt. Area, Rockbridge Co. west central Virginia Various hardwoods – scarlet, red, white and chestnut oaks, tulip poplar	Overall caterpillar abundance was lower on foliage from sprayed plots, but differences were modest and mostly non-significant. Greatest impacts were in macrolepidoptera fauna beneath burlap bands. 95% of lepidoptera were shelter-forming microleps (leaf rollers, etc.) that could avoid the treated foliage. Caterpillar numbers rebounded in the first post-spray year, with only 2 species remaining significantly less common on treatment plots; reduced abundance of these two species remained through the 2 nd post-year samples.	Yes	Yes	Wagner and others, 1996
42 species of native Lepidoptera	Foray 48B and Dipel AF	Laboratory bioassay	Effect of two formulations of <i>B.t.k</i> was evaluated on 42 species on instars that would be present in the field at the time of treatment. Mortality was significant for 57-64% (Dipel and Foray, respectively) of species tested. All butterfly species were highly sensitive versus 10 of 38 moth species. Late instars of 7 of 8 species of xylenini noctuids were insensitive to <i>B.t.k</i> .	Yes	Yes	Peacock and others, 1998
668 nontarget native Lepidoptera species	2-3 applications of Foray 48B @ 24BIU/ac each application; Gypchek in sensitive areas	Lower Cape Fear region; flatwoods and savannahs of southeastern North Carolina	Black light trapping of adult moths compared <i>B.t.k</i> treatment to Gypchek treated plots. A major depression of macromoth abundance occurred independently of treatment effects (possibly weather-related). Moth abundance in <i>B.t.k</i> treated plots was lower than in Gypchek treated plots the fall of the year of treatment and for univoltine moths the following spring. Increases in moth numbers occurred between 1994 and 1995. 668 sopecies were sampled of which 79% were Geometridae and Noctuidae. Found little evidence that any species was extirpated; and several rare species either survived	Yes	Yes	Hall and others, 1999

SPECIES	APPLICATION RATE	SITE DESCRIPTION	RESULTS AND CONCLUSIONS	STUDY R ²	DESIGN C	STUDY
			<p>or quickly recolonized the <i>B.t.k</i> blocks.</p> <p>Nonetheless, recommend using Gypchek to protect core natural areas. Protection of at least large blocks of high quality habitat may play a role in re-colonization of depleted areas.</p>			

APPENDIX F: RELEVANT FOREST PLAN STANDARDS AND GUIDELINES

Colville (LRMP 1988)

- Suppress insect and disease outbreaks that threaten the wildlife habitat objective (LRMP, p. 4-72).
- Prevent or suppress insect and disease outbreaks that are an imminent threat to caribou habitat, in a manner consistent with habitat management objectives (LRMP, p. 4-76).
- Prevent or suppress insect and disease outbreaks that threaten the recreation objective (LRMP, p. 4-79).
- Prevent or suppress insect and disease outbreaks that threaten the recreation or wildlife objectives (LRMP, p. 4-83).
- Prevent or suppress insect and disease outbreaks that threaten the recreational visual objective (LRMP, p. 4-87).
- Insect and disease control is appropriate to protect the uniqueness of the Research Natural Area (LRMP, p. 4-91).
- Prevent and suppress insect and disease outbreaks that threaten visual resources (LRMP, p. 4-96 and 4-100).
- Prevent or suppress insect and disease outbreaks that threaten the timber values (LRMP, p. 4-104).
- Prevent or suppress insect and disease outbreaks that threaten the winter range objective (LRMP, p. 4-108).
- Insect and disease characteristics will be monitored and evaluated. If conditions pose a significant threat to lands outside the wilderness or caribou habitat inside, control measures may be taken with biological controls to be given preference (LRMP, p. 4-113).
- Prevent or suppress insect and disease outbreaks that threaten the semi-primitive objective (LRMP, p. 4-117).
- Prevent or suppress insect and disease outbreaks that threaten the Semi-Primitive, Non-Motorized objective or that are an imminent threat to caribou habitat (LRMP, p. 4-122).

Okanogan (LRMP 1990)

(The following are management directions for land both in and outside the Northwest Forest Plan)

- Integrated Pest Management strategies shall be used to manage pests in conformance with the resources goals of the management areas (LRMP, p. 4-53, Forest Wide Standards and Guidelines).
- Insects and diseases may be suppressed when necessary to protect the recreation and the scenic values in the area or in adjacent Management Areas, or when necessary to prevent the spread of insects and disease to adjacent Management Areas where timber production is a primary emphasis and when projected volume losses would be substantial. Pest populations shall be monitored to assure that there is not an insect buildup that could spread to adjacent Management Areas (LRMP, p. 4-64). *Applies to lands outside the NWFP and lands in LSRs.*
- Insects and diseases shall be suppressed when outbreaks threaten managed resources and/or users. Suppression methods that minimize site disturbance should be used. Stands shall be managed to control insect and disease problems and to control outbreaks, to the extent practicable (LRMP, p. 4-69). *Applies to lands outside the NWFP and lands in Matrix and Administratively Withdrawn Lands.*
- Suppression may be allowed where insects and diseases would adversely affect achieving the resource goals in the [North Cascades Highway] area (LRMP, p. 4-72). *Applies to lands under and outside the NWFP.*
- Where pest management activities are prescribed [in Research Natural Areas], they shall be specific against the target organism and induce minimal impact to other components of the ecosystem (LRMP, pg. 4-75). *Applies to lands under and outside the NWFP.*
- Insects and diseases may be suppressed when necessary to protect the wildlife habitat values in [Mountain Goat Habitat] area, or when necessary to prevent the spread of insects and diseases to adjacent management areas where timber production is a primary emphasis and when projected volume losses would be substantial (LRMP, pg. 4-77). *Applies to lands inside and outside LSR's and to lands outside the NWFP.*
- Suppress insects and diseases when adversely affecting vegetation essential for maintaining [Bighorn Sheep] habitat and unacceptable damage to resources would occur if no controls are applied (LRMP, pg. 4-80). *Applies to lands within LSR's and outside the NWFP.*
- Suppress insects and diseases when adversely affecting vegetation essential for maintaining wildlife habitat and/or unacceptable damage to resources would occur if no controls are applied (LRMP, pg. 4-85). *Applies to lands outside of the NWFP and to Matrix lands and to Administratively Withdrawn Lands.*
- Insect and disease outbreaks [in Wilderness without trails] shall not be artificially controlled unless it is necessary to prevent unacceptable resource damage to resources on adjacent lands or an unnatural loss to the wilderness resource. If control becomes necessary, it shall be carried out by measures that have the least adverse impact on the wilderness resource and are compatible with wilderness objectives (LRMP, pg. 4-90). *Applies to lands under and outside the NWFP.*
- Insect and disease outbreaks [in Wilderness with trails] shall not be artificially controlled unless it is necessary to prevent unacceptable resource damage to resources on adjacent lands or an unnatural loss to the wilderness resource. If control becomes necessary, it shall be carried out by measures that have the least adverse impact on the wilderness resource and are compatible with wilderness objectives (LRMP, pg. 4-97). *Applies to lands under and outside the NWFP.*

[At Developed Recreation Sites], control insect and disease infestations to provide a safe environment for recreation users, to protect facilities, and to prevent the spread of introduced pests to the surrounding management areas (LRMP, pg, 4-99). *Applies to lands inside LSRs and Matrix lands and within Administratively Withdrawn Lands and lands outside the NWFP.*

No action should be taken against insects and diseases unless an outbreak threatens the plants being protected or is inconsistent with the management goals for the adjacent areas (LRMP, pg, 4-100). *Forest wide direction and ROD direction would apply.*

Aggressively suppress insects and diseases when outbreaks significantly threaten [Timber and Range] resource management. Use principles of integrated pest management to select suppression strategies (LRMP, pg, 4-106). *Applies to lands inside LSR's and Matrix lands and lands outside the NWFP.*

Suppress insects and diseases when adversely affecting vegetation essential for maintaining [Deer Winter Range] and unacceptable damage to resources would occur if no controls are applied (LRMP, pg, 4-109). *Applies to lands inside LSR's, Matrix lands, and Administratively Withdrawn Lands and lands outside the NWFP.*

Wenatchee (LRMP 1990)

Survey stands for early detection of pest problems. Coordinate with the Regional Forest Pest Management Unit for technical assistance. Pesticide application will conform to EPA regulations and label restrictions, and will [occur] only after site-specific evaluations have been made. Utilize integrated pest management strategy to prevent unacceptable resource damage and to meet resource objectives in an economically efficient manner (LRMP, p. IV-103).

Insect and disease outbreaks should be suppressed when studies are threatened and/or unacceptable damage to [Experimental Forest] resources would occur if no controls were applied. Research should develop and/or follow sound integrated pest management principles. Utilize IPM strategies to prevent unacceptable pest damage and meet resource objectives. Coordinate all activities with the Experimental Station Project Leader during planning and implementation of project (LRMP, p. IV-111).

Suppress insects and diseases when necessary to protect [Key Deer and Elk Habitat] resource values. Utilize IPM strategies to prevent unacceptable pest damage and meet resource objectives (LRMP, p. IV-120).

Suppress Forest pests when they adversely affect the vegetation component essential for maintaining the [Riparian-Aquatic Habitat Protection] zone and/or when unacceptable damage to resources would occur if no controls were applied (LRMP, p. IV-127).

Suppress insects and diseases when adversely affecting vegetation essential for maintaining [Key Big Game Habitat/Unroaded] and/or unacceptable damage to resources would occur if no controls were applied. Utilize IPM strategies to prevent unacceptable pest damage and meet resource objectives (LRMP, p. IV-134).

Aggressively suppress insects and diseases when outbreaks threaten resource management. Utilize high intensity prevention with sound IPM principles (LRMP, p. IV-139).

[Along the Mather Memorial Parkway], suppress insects and diseases when outbreaks threaten managed resources and/or users. Utilize IPM strategies to prevent unacceptable pest damage and meet resource objectives (LRMP, p. IV-145).

Suppress insect and disease outbreaks to ensure protection of old-growth trees and other resources. Insects and disease are important components of old-growth. Survey insects and diseases common to old-growth that may threaten immediate and adjacent areas (LRMP, p. IV-152).

Suppress insect and disease outbreaks to ensure protection of old-growth timber and other resources. Utilize IPM strategies to prevent unacceptable pest damage and meet resource objectives. Survey insects and diseases common to old-growth that may threaten immediate and adjacent areas (LRMP, p. IV-158).

Suppress insect and disease outbreaks with a minimum of resource disturbance to protect [Developed Recreation sites] and/or users. Favor biological and silvicultural treatments over pesticides when possible. Utilize high intensity preventive efforts featuring Integrated Pest Management (LRMP, p. IV-164).

Suppress insects and diseases when outbreaks threaten [Dispersed Recreation, Unroaded, Motorized] resources and/or users. Utilize IPM strategies to prevent unacceptable pest damage and meet resource objectives (LRMP, p. IV-169).

[At Dispersed Recreation, Unroaded, Non-Motorized sites], suppress insects and diseases when outbreaks threaten managed resources and/or users where possible. Utilize IPM strategies to prevent unacceptable pest damage and meet resource objectives (LRMP, p. IV-175).

[In Dispersed Recreation/Unroaded/Timber Harvest areas], suppress insects and diseases when outbreaks threaten managed resources and/or users. Utilize IPM strategies to prevent unacceptable pest damage and meet resource objectives (LRMP, p. IV-181).

Suppress insect and diseases when adversely affecting vegetation essential for maintaining livestock and/or when unacceptable damage to resources would occur if no controls were applied. Utilize IPM strategies to prevent unacceptable pest damage and meet resource objectives (LRMP, p. IV-188).

Suppress insect and disease outbreaks to meet Research Natural Area objectives. Use these areas to observe insects and diseases in undisturbed areas. Survey pest populations as a management strategy for adjacent resource areas (LRMP, p. IV-192).

Suppress insects and diseases when outbreaks threaten managed [Classified Special Area] resources and/or users (LRMP, p. IV-197). Utilize IPM strategies to prevent unacceptable pest damage and meet resource objectives (LRMP, p. IV-204).

Suppress insects and diseases when outbreaks threaten [Scenic Travel-Retention] managed resources and/or users. Utilize IPM strategies to prevent unacceptable pest damage and meet resource objectives (LRMP, p. IV-213).

Suppress insects and diseases when outbreaks threaten managed [Scenic Travel-Partial Retention] resources and/or users. Use suppression methods that minimize site disturbance. Utilize IPM strategies to prevent unacceptable pest damage and meet resource objectives (LRMP, p. IV-222).

Suppress insects and diseases when outbreaks threaten managed [Utility Corridors] and integrity of structures. Utilize IPM strategies to prevent unacceptable pest damage and meet resource objectives (LRMP, p. IV-226).

Suppress insects and diseases when outbreaks threaten [Wilderness] resources in adjacent areas. Favor biological controls when available. Survey pest populations as a management strategy for adjacent resource areas (LRMP, p. IV-232).

Suppress insect and disease outbreaks to preserve recreational character and adjacent resources. Avoid degradation of water quality. Utilize IPM strategies to prevent unacceptable pest damage and meet resource objectives (LRMP, p. IV-239).

Suppress insect and disease outbreaks when necessary to protect [Wild River] character or adjacent resources. Utilize IPM strategies to prevent unacceptable pest damage and meet resource objectives (LRMP, p. IV-245).

Umatilla (LRMP 1990)

Protect forest and range resources and values from unacceptable losses due to destructive forest pests through the practice of integrated resource management (LRMP, p. 4-3).

Integrated pest management prevention, and suppression strategies will be utilized to manage pests within the constraints of laws and regulations and to meet Forest-wide management objectives. Methods may include management practices (cultural or silvicultural); biological, mechanical, manual, prescribed fire, or chemical treatments; or regulatory measures. All pest management suppression project proposals will be analyzed through the NEPA process to select an appropriate suppression response. Individual project plans will specify licensing approval and public notification requirements for pesticide use on a case-by-case basis (LRMP, p. 4-89).

Use integrated pest management principles and strategies in meeting [Non-motorized Dispersed Recreation] management area objectives. Suppress pests when outbreaks threaten recreation objectives or resources in adjacent areas. Favor biological methods when available (LRMP, p. 4-96).

Use integrated pest management principles and strategies in meeting OHV Recreation management area objectives. Suppress pests when outbreaks threaten dispersed recreation objectives or resources in adjacent areas. Favor biological methods when available (LRMP, p. 4-98).

Use integrated pest management principles and strategies to manage insect and disease pests in meeting Viewshed 1 objectives. All treatment strategies may be utilized. Emphasize strategies that improve visual quality, aesthetics, and safety (LRMP, p. 4-104).

Use integrated pest management principles and strategies to manage insect and disease pests in meeting Viewshed 2 objectives. All treatment strategies may be utilized. Emphasize strategies that improve visual quality, aesthetics, and safety (LRMP, p. 4-110).

Use integrated pest management principles to manage insect and diseases in meeting Roaded Natural management area objectives. All treatment strategies may be utilized. Emphasize strategies that improve visual quality, aesthetics, and safety. Suppress pests when outbreaks threaten users and/or managed resources. Use suppression methods that minimize site disturbance (LRMP, p. 4-116).

[At Developed Recreation sites], use integrated pest management principles and strategies to prevent or control unacceptable vegetative losses due to insects and diseases. Emphasize prevention and early detection measures. Prevent, control, or suppress pest outbreaks with a minimum of disturbance to protect users and/or developments. Favor biological and silvicultural treatments where possible (LRMP, p. 4-120).

[Along Wild and Scenic Rivers], use integrated pest management principles and methods. Prescribed fire may be used to help reduce stocking and conditions favorable for bark beetle and other insects and diseases (LRMP, p. 4-127).

Use integrated pest management principles to manage insects and diseases in meeting scenic area objectives. Suppress pests when outbreaks threaten scenic area objectives or resources in adjacent areas. Favor biological methods when available. Control of defoliators may be accomplished by spraying following approval of an environmental analysis (LRMP, p. 4-130).

[In Special Interest Areas], utilize integrated pest management principles and strategies to prevent unacceptable vegetative losses due to pests. Emphasize prevention and early detection measures. Suppress pest outbreaks with a minimum of disturbance to protect users and/or resources. Favor biological and silvicultural treatments where possible (LRMP, p. 4-133).

[In the Wenaha-Tucannon Special Management Area], use integrated pest management principles and strategies in meeting management area objectives. Monitoring and detection of pest conditions and populations will be done so that corrective treatments can be prescribed early (LRMP, p. 4-137).

- Monitor the levels and activities of pests normally associated with Wilderness and old-growth ecosystems. Most insect and disease agents do not normally pose threats to adjacent lands; effects of endemic levels will be accepted as naturally occurring phenomena (LRMP, p. 4-143).
- Monitor the levels and activities of pests normally associated with old-growth ecosystems. Effects of endemic levels will be accepted as naturally occurring phenomena. No special management practices will be utilized to control losses from insects and diseases at endemic levels. Suppress or control pests when outbreaks reach epidemic levels and threaten catastrophic loss of dedicated old-growth resources or other resources on adjacent lands. Favor biological treatment methods or prescribed burning. Integrated pest management methods will not conflict with wildlife objectives (LRMP, p. 4-146).
- Use integrated pest management principles to meet [Managed Old-Growth] area objectives. Emphasis will be on the prevention of stand and fuels conditions that increase pest populations above epidemic levels. Natural or endemic levels are acceptable and no special management practices will be employed to control losses from insects or diseases at these levels. Suppress or control pests when outbreaks threaten managed old-growth resources, the ability of stands to become old-growth, or other resources on adjacent lands. IPM methods will not conflict with wildlife objectives (LRMP, p. 4-150).
- Use integrated pest management principles and strategies in managing insects and disease to meet [Big Game Winter Range] management objectives. Monitoring and detection of pest conditions and populations will be done so that corrective treatments, consistent with resource objectives, can be prescribed early. Aggressively suppress insects and disease using cost efficient strategies when outbreaks threaten resource objectives (LRMP, p. 4-154).
- Use integrated pest management principles and strategies in managing insects and disease to meet [Sensitive Big Game Winter Range] management objectives. Monitoring and detection of pest conditions and populations will be done so that corrective treatments consistent with resource objectives can be prescribed at the earliest opportunity. Aggressively suppress insects and disease using cost efficient strategies when outbreaks threaten resource objectives (LRMP, p. 4-157).
- Use integrated pest management principles and strategies in managing insects and disease to meet [Wildlife Habitat] management objectives. Detection and monitoring of pest conditions and populations will be done so that corrective treatments consistent with resource objectives can be prescribed at the earliest opportunity. Aggressively suppress insects and disease using cost efficient strategies when outbreaks threaten resource objectives (LRMP, p. 4-162).
- Use integrated pest management principles and strategies in managing insects and disease to meet [Riparian] management objectives. Monitoring and detection of pest conditions and populations will be done so that corrective treatments consistent with resource objectives can be prescribed at the earliest opportunity. The use of pesticides must not conflict with riparian/wildlife management objectives (LRMP, p. 4-166).
- Use integrated pest management principles and strategies in managing insects and disease to meet [Special Fish Management Area] management objectives. Monitoring and detection of pest conditions and populations will be done so that corrective treatments consistent with resource objectives can be prescribed at the earliest opportunity. Aggressively suppress insects and disease using cost efficient strategies when outbreaks threaten resource objectives. The use of pesticides must not conflict with riparian, fish, and water management objectives (LRMP, p. 4-170).
- Use integrated pest management principles and strategies in meeting [Grass-Tree Mosaic] management area objectives. Aggressively suppress insects and disease using cost efficient strategies when outbreaks threaten resource objectives or resources on other lands. Favor biological methods in meeting protection and suppression requirements. Control of defoliators may also be accomplished by spraying following approval of an environmental analysis (LRMP, p. 4-174).
- Action to control insects or diseases [in a Research Natural Area] will not be taken unless an outbreak will drastically alter the natural processes with the RNA, or if it poses an unacceptable threat to resources adjacent to the RNA. Treatment to control insects and diseases within RNA will support and promote the basic objective and purposes of establishing the area (*FSM 4063.3(8)*). Biological methods are preferred (LRMP, p. 4-177).
- Use integrated pest management principles and strategies in managing insects and disease to meet [Timber and Forage] management objectives. Monitoring and detection of pest conditions and populations will be done so that corrective treatments consistent with resource objectives can be prescribed at the earliest opportunity. Aggressively suppress insects and disease using cost efficient strategies when outbreaks threaten resource objectives. Use a variety of methods in meeting protection and suppression requirements (LRMP, p. 4-181).
- Use integrated pest management principles and strategies in managing insects and disease to meet [Timber and Big Game] management objectives. Monitoring and detection of pest conditions and populations will be done so that corrective treatments consistent with resource objectives can be prescribed at the earliest opportunity. Protect growing stock consistent with the level of investment by practicing high intensity prevention activities. Aggressively suppress insects and disease using cost efficient strategies when outbreaks threaten resource objectives. Use a variety of methods in meeting protection and suppression requirements (LRMP, p. 4-186).
- [In the Mill Creek Municipal Watershed-Undeveloped], use integrated pest management principles and strategies in managing insects and diseases to meet management objectives. Management of insects and diseases (including suppression activities) is permitted. In coordination with the City of Walla Walla, prevent unacceptable damage in the watershed. The preferred method is use of biological controls (LRMP, p. 4-188).

[In the High Ridge Evaluation Area], use integrated pest management principles and strategies in managing insects and disease to meet management objectives. Monitoring and detection of pest conditions and populations will be done so that corrective treatments consistent with resource objectives can be prescribed at the earliest opportunity. Protect growing stock consistent with the level of investment by practicing high intensity prevention activities. Aggressively suppress insects and disease using cost efficient strategies when outbreaks threaten resource objectives. Use a variety of methods in meeting protection and suppression requirements (LRMP, p. 4-190).

[In the Walla Walla River Watershed], use integrated pest management principles and strategies in managing insects and disease to meet management objectives. Monitoring and detection of pest conditions and populations will be done so that corrective treatments consistent with resource objectives can be prescribed at the earliest opportunity. Suppress pests using cost efficient strategies when outbreaks threaten dispersed recreation, water and/or wildlife habitat objectives or resources in adjacent areas. Favor biological methods when available. The use of pesticides will not conflict with water and habitat objectives (LRMP, p. 4-195).

Wallowa-Whitman (LRMP 1990)

All projects or activities (including but not limited to pesticide application,) with the potential to adversely affect surface or ground waters will include constraints and/or mitigation measures designed to prevent contamination (LRMP, p. 4-24, 4-62).

Use fertilizers and pesticides (chemical or biological) within the watersheds only in emergencies, and then only following close coordination with the city (LRMP, p. 4-26).

Use integrated pest management strategies for early detection, suppression, and prevention of Forest pests and to manage pests within the constraints of laws and regulations (LRMP, p. 4-55).

Prevent and/or suppress insects and diseases using integrated pest management techniques when outbreaks threaten [Timber Production Emphasis] resource management objectives. Activities might include... application of pesticides for defoliators and cone insects (LRMP, p. 4-58).

Monitor the levels and activities of pests normally associated with Wilderness and old-growth ecosystems. Most insect and disease agents do not normally pose threats to adjacent lands; effects of endemic levels will be accepted as naturally occurring phenomena (LRMP, p. 4-65).

[In the Philips Lake Area], apply Forest-Wide standards and guidelines for insects and disease (LRMP, p. 4-68).

Insect or disease outbreaks affecting trees will not be artificially controlled unless it is necessary to protect [Back Country] resources in adjacent management areas (LRMP, p. 4-70).

[Along Wild and Scenic Rivers], control forest pests in a manner compatible with the intent of the act and management objectives of contiguous National Forest System lands (*FSM 3400*, LRMP, p. 4-72).

[In the HCNRA Snake River Corridor], apply Forest-Wide standards and guidelines for insects and disease (LRMP, p. 4-76).

[In HCNRA Dispersed Recreation/Native Vegetation areas], emphasize biological methods when necessary to control insects or noxious weeds, although abiotic methods are not prohibited (LRMP, p. 4-78).

Apply Forest-Wide standards and guidelines for insects and disease [in HCNRA Forage Production areas] (LRMP, p. 4-80).

[In HCNRA Dispersed Recreation/Timber Management areas], apply Forest-Wide standards and guidelines for insects and disease (LRMP, p. 4-82).

The decision on treatment of Forest pests [in Research Natural Areas] will be made on a case-by-case basis. Where pest management activities are prescribed, they shall be as specific as possible against target organisms and induce minimal impact to other components of the ecosystem (LRMP, p. 4-85).

[In the Homestead Further Planning Area], permit artificial control of Forest pests only to protect values outside the further planning area (LRMP, p. 4-86).

[In the Starky Experimental Forest and Range area], apply Forest-wide standards and guidelines provided preventive and suppressive techniques are consistent with research purposes (LRMP, p. 4-88).

Control of pests is encouraged where pests threaten destruction of an old-growth stand. Where destruction of the old-growth is not likely, artificial control of pests will occur only when this can be accomplished without adverse effects on old-growth values (LRMP, p. 4-91).

Prevent insect and disease outbreaks [at Administrative and Recreation Sites] including noxious weeds, with a minimum of disturbance to developments or users. Favor biological and silvicultural treatments (LRMP, p. 4-93).

[At Power Transportation Facilities], apply Forest-wide standards and guidelines for insects and disease (LRMP, p. 4-94).

[In Anadromous Fish Emphasis areas], practice high intensity prevention activities such as monitoring pest populations to be forewarned of outbreaks. Use pesticide only where this use can occur without adversely affecting fish habitat (LRMP, p. 4-98).

Malheur (LRMP 1990)

Determine the effects of management practices on the incidence and severity of pathogens and insects as they affect long-term timber productivity. Evaluate the effects of insects and pathogens on forest composition and the influence of forest composition on the population dynamics of insects and pathogens (LRMP, p. II-9).

Site-specific project analysis will address both short-term and long-term effects, particularly in the case of cover where short-term options to treat stands for insects and disease will improve forest health in the long term (LRMP, p. III-8).

Apply integrated pest management principles to minimize the impacts of the mountain pine beetle, western spruce budworm, tussock moth, and other insect and disease infestations to the extent necessary to achieve the overall goals and objectives of this Forest Plan (LRMP, p. IV-45).

Continually monitor pest populations and implement activities to prevent population buildups to epidemic levels. Aggressively suppress insects and diseases when outbreaks threaten timber management objectives (LRMP, p. IV-51).

Apply integrated pest management principles to minimize losses and protect riparian area values (LRMP, p. IV-61).

Apply integrated pest management principles to minimize losses and protect [anadromous] riparian area values (LRMP, p. IV-68).

Allow endemic levels of infestation to occur [in Big-Game Winter Range]. Treat epidemic levels that threaten eagle roost values or adjacent lands (LRMP, p. IV-75).

Allow endemic levels of infestations [in the Strawberry Mountain Wilderness]. Treat epidemic levels that severely threaten adjacent lands (LRMP, p. IV-78).

Allow endemic levels of infestations [in the Monument Rock Wilderness]. Treat epidemic levels that severely threaten adjacent lands (LRMP, p. IV-87).

[In the Monument Rock Wilderness – Primitive Areas], manage to allow natural ecological successions, including infestation of insects, unless they endanger significant resources outside the wilderness (LRMP, p. IV-88).

Allow endemic levels to occur [in Scenic Areas]. Treat epidemics that threaten scenic values or adjacent lands (LRMP, p. IV-92).

Allow endemic infestations to occur [in Special Interest Areas]. Treat epidemics that threaten special interest areas or adjacent lands (LRMP, p. IV-94).

Take action against endemic or epidemic levels of insects or diseases in accordance with the direction given in the [Research Natural Area] establishment report (LRMP, p. IV-96).

Allow endemic infestations to occur [in Semi-Primitive, Non-Motorized Recreation Areas]. Treat epidemics that threaten semi-primitive, non-motorized recreation values or adjacent lands (LRMP, p. IV-98).

Allow endemic infestation to occur [in Semi-Primitive, Motorized Recreation Areas]. Treat epidemics that threaten semi-primitive motorized values or adjacent lands (LRMP, p. IV-100).

Allow endemic levels of infestation to occur [in Old-Growth]. Favor biological methods of control if at an epidemic level (LRMP, p. IV-107).

Control insect and disease epidemics if necessary to protect other resource values or to prevent spread to adjacent, suitable forestlands (LRMP, p. IV-114).

[In the Byram Gulch Municipal Supply Watershed], protect water quality and quantity when applying integrated pest management practices (LRMP, p. IV-116).

[In the Long Creek Municipal Supply Watershed], protect water quality and quantity when applying integrated pest management practices (LRMP, p. IV-118).

Allow endemic infestations to occur [in Wild and Scenic River areas]. Epidemics that threaten scenic values or adjacent lands may be treated (LRMP, p. IV-137).

Ochoco (LRMP 1989)

Utilize Integrated Pest Management strategies to maintain forest health. Resource activities to control pests will depend on site-specific analysis and may vary greatly from year to year. Emphasis will be on prevention rather than control. When control is necessary, the method with the least impact on the environment will be used (LRMP, p. 4-12).

Utilize Integrated Pest Management strategies to manage pests within the constraints of laws and regulations, and meet Forest management objectives. IPM strategies include manual, mechanical, cultural, biological, chemical, prescribed fire, and regulatory means. Select strategy through the environmental process, and in compliance with the Regional Vegetation Management Environmental Impact Statement, 1988. Coordinate strategies with the Agricultural Pest Health Inspection Service (APHIS) when proposing major Forest-wide control projects. Pesticide application, if used, will conform to EPA regulations, label restrictions, and the Regional Environmental Impact Statement on chemical applications. Use the integrated pest management strategies on forested types, as displayed in Table 4-32. Exceptions for individual management areas are discussed in management area standards and guidelines for Forest health. (Table 4-32: Short Term Strategy – treat infested fir stands with biological or chemical insecticides).

[In Wilderness], insect and disease outbreaks will not be controlled unless treatment is necessary to prevent unacceptable damage to resources on adjacent lands or an unnatural loss to wilderness resource due to exotic pests. Management of insects and diseases in wilderness will follow direction in *FSM 2324.1* (LRMP, Table 4-33, p. 4-152).

- [In Research Natural Areas (RNA's)], take no action to control insects or diseases, unless an outbreak will drastically alter the natural processes within the RNA. Treatment to control insects and diseases within RNA must support and promote the basic objectives and purposes of establishing the area. (*FSM 4063.3(8)*, LRMP, Table 4-33, p. 4-152).
- [In Old-growth], generally, insects and diseases will not be controlled or suppressed. Exceptions may occur when treatment is necessary to prevent unacceptable damage to resources on adjacent lands or to the old-growth resource. Acceptable treatments are prescribed burning and use of synthetic or biological chemicals, based on site-specific environmental analysis (LRMP, Table 4-33, p. 4-152).
- All treatment strategies may be utilized to manage insects and diseases to meet [Visuals] management area objectives. Emphasize strategies that improve aesthetics and safety (LRMP, Table 4-33, p. 4-152).
- [In Roadless Areas], control of defoliators may also be done by spraying following environmental analysis (LRMP, Table 4-33, p. 4-152).
- [In Recreation/Wildlife Emphasis Areas], generally, treatment of insect and disease conditions will not be in high priority, except when the ability of the forest resource to meet the area objectives is threatened. Treatment of pest conditions will also be considered when damage is catastrophic and threatening to the surrounding area. There are no constraints for selection of control strategy (LRMP, Table 4-33, p. 4-152).
- [In Eagle Roosting Areas], utilize all strategies to meet the area objectives for providing roosting habitat for bald eagles. All treatments must meet seasonal restriction (Dec. 1 to May 1) (LRMP, Table 4-33, p. 4-153).
- [At Recreation Sites and Facilities], utilize all methods to prevent or suppress insect and disease outbreaks. Control of defoliators in the mixed conifer type is also emphasized to meet visual objectives (LRMP, Table 4-33, p. 4-153).
- [In Riparian Areas], utilize all methods, except chemical spraying, to prevent or suppress insect and disease outbreaks. Pest management activities must consider the effects on the stands ability to provide shade, bank stability, and large woody material to the stream (LRMP, Table 4-33, p. 4-153).
- [In Winter Range], take aggressive action to suppress insect or disease caused mortality, where action could prevent loss of winter thermal cover and is cost effective (LRMP, Table 4-33, p. 4-153).
- [In General Forest Winter Range], utilize all methods to prevent or suppress insect and disease outbreaks (LRMP, Table 4-33, p. 4-153).
- [Throughout the Forest], utilize an integrated pest management approach to managing insect and disease conditions. Aggressive monitoring and detection of pest conditions and populations will be done so corrective treatments can be prescribed early (LRMP, Table 4-33, p. 4-153).

Winema (LRMP 1990)

- Control endemic levels of Forest pests, and provide controls that are compatible with resource objectives. The Forest will rely on integrated pest management principles to avoid creation of forest pest problems and to suppress existing forest pest problems (LRMP, p. 4-10).
- All planned activities shall include integrated pest management practices. All insect and disease control projects shall be carried out in ways that meet management area objectives. If normal insect surveillance indicates the threat of an epidemic, project-level detection and control operations, including coordination with other land ownership's, shall be accomplished on a forest wide basis (LRMP, p. 4-59).
- No effort will be made to control insect and disease outbreaks [in Semi-Primitive Recreation areas], except when pest or pathogen populations are a threat to adjacent lands. The need for control actions will be evaluated on a case-by-case basis through the environmental analysis process (LRMP, p. 4-89).
- [In Unique Management Areas], insect and disease outbreaks shall be managed with a minimum of resource disturbance. Biological and silvicultural treatments should be emphasized (LRMP, p. 4-114).
- [In the Saddle Mountain Cultural Resource Area], insect or disease outbreaks shall not be artificially controlled unless it is necessary to prevent unacceptable resource damage to resources on adjacent lands or an unnatural loss to the management area's resources. If control becomes necessary, it shall be carried out by measures that have the least adverse impacts on the management area's resources and that are compatible with the management area's objectives (LRMP, p. 4-117).
- [Along the Sycan National Wild and Scenic River], insect and disease outbreaks shall be suppressed with a minimum of resource disturbance (LRMP, p. 4-119).
- Insect or disease outbreaks shall not be artificially controlled unless it is necessary to prevent unacceptable [Wilderness] resource damage to resources on adjacent lands or an unnatural loss to Wilderness resource. If control becomes necessary, it shall be carried out by measures that have the least adverse impact on the Wilderness resource and that are compatible with Wilderness objectives (LRMP, p. 4-123).
- Insect and disease outbreaks will be managed with a minimum of [Bald Eagle Habitat] resource disturbance. Biological and silvicultural treatments will be emphasized (LRMP, p. 4-145).
- Insect and disease outbreaks shall not be suppressed [in Research Natural Areas] (LRMP, p. 4-158).

Fremont (LRMP 1989)

Long-term sight productivity will be considered in all silvicultural prescriptions. Items to be integrated into the prescription will include, but are not limited to, and effect of frequency of harvest entries on insect and disease and occurrence (LRMP, p. 73).

Integrated pest management strategies will be utilized to manage pests within the constraints of laws and regulations and to meet Forest management objectives. Prescribed fire and manual, mechanical, cultural, biological, and chemical strategies will be used (LRMP, p. 74).

Stands may require protection from biological agents in order to meet stocking and growth standards (LRMP, p. 74).

Protect RNA's from fire, insect, disease, and animal damage primarily by management practices outside the area such as under-burning, thinning, etc. (LRMP, p. 95).

Integrated pest management strategies will be utilized to manage pests within the constraints of laws and regulations and to meet Forest management objectives. IPM strategies include manual, mechanical, cultural, biological, chemical, prescribed fire, and regulatory means (LRMP, p. 101).

Stand treatments will include controlling stocking levels and species mix; improving growth rates; protecting stands from insects, disease, and other damage; and regenerating old stands no longer showing optimum growth rates (LRMP, p. 125, second paragraph).

Salvage operations will take place only when catastrophic events occur (such as wildlife, insect infestations, wind throw, etc.) and the affected old-growth stand is no longer considered suitable old-growth habitat. A new old-growth stand should be delineated to replace the original habitat (LRMP, p. 139).

Stand treatments will include controlling stocking levels and species mix; improving growth rates; protecting stands from insects, disease, and other damage; (LRMP, p. 145).

Stands should not be salvage logged at other than the prescribed entry cycle except where wildfire, bark beetles, disease, or other conditions have created catastrophic mortality (LRMP, p. 151).

Temporary departure from assigned VQOs may be necessary in areas highly susceptible to insect or disease epidemics in order to protect long-term values. Suppress pests when outbreaks threaten managed resources and/or users. Use methods that minimize site disturbance. Utilize integrated pest management strategies to prevent unacceptable damage in visual corridors (LRMP, p. 155).

Temporary departure from the Partial Retention VQO may be necessary in areas highly susceptible to insect or disease epidemics, in order to protect long-term values (LRMP, p. 157).

Suppress pests when outbreaks threaten wilderness objectives or resources in adjacent areas. Such action shall occur only when authorization is granted per FSM 2320. Favor biological methods when available. Monitor pest populations within the Wilderness as a management strategy for adjacent resource areas (LRMP, p. 179).

Suppress pest outbreaks with a minimum of disturbance to protect developments and/or users. Favor biological and silvicultural treatments where possible (LRMP, p. 192).

APPENDIX G: PROJECT GUIDELINES

PROJECT PLANS

Prior to implementation of the preferred alternative, each affected Forest will develop a project plan specific to their Forest and situations. Forests can combine operations and prepare one plan for several Forests. This plan will describe the logistics of the proposed operations in depth. In addition, the plan will address how the public is to be notified of spray operations, what specific safety concerns exist or are expected, how project operations will be monitored, and how accidents and spills may be prevented. Contingency plans will be included that describe procedures that would be followed in the event there are accidents or spills.

PUBLIC INFORMATION PLAN

Prior to implementation, a public information plan will be developed. Timely notification will be given to anyone who may be near the project area during operations. If requested, individuals may be notified in advance of spray dates and times. For example, a range permittee may request notification so he/she can move animals prior to project implementation. Warning and informational signs will be placed along the perimeter of treatment areas.

PRETREATMENT REVIEWS

This document does not imply that blanket spraying will occur over all acres on an affected Forest. Treatment will only occur when defoliation is eminent. The proposed treatment areas will be grouped into Entomological Units (EU's) that would be similar in location and characteristics. Insect population monitoring plots will be placed throughout the Entomological Units. Prior to beginning operations, population levels of the tussock moth will be verified to ensure insect populations are present and at or near suboutbreak or outbreak levels. This will be done according to an entomological sampling plan for early instar sampling, although cocoon/egg mass sampling may also be done in the early spring before egg hatch. Early instar levels will determine if adequate populations are present at levels to warrant treatment (see DFTM Population Sampling Appendix). If populations are not at suboutbreak or outbreak levels, the area will not be treated. If, when these units are sampled, there are mixed population levels in the EU, it will be further subdivided and additional population measurements taken to quantify them as separate areas. Those areas with low populations will be dropped from treatment. It is possible that in some cases, high populations will occur in only a limited area within the larger Entomological Unit with low population levels. In this case, it may be logistically or operationally difficult to treat only this limited area. The decision to drop the isolated area or continue to keep it in the treatment schedule will depend on the resource at risk for that particular site and be made in conjunction with the appropriate Forest Supervisor or designated representative.

Once population levels have been verified, Project and Public Information Plans will be followed.

OPERATIONS

Treatment area boundaries, heliports, and airstrips will be mapped prior to beginning operations and will be available upon request. Treatment area boundaries will be described (when possible) by topographical or other physical features. Proposed treatment areas will be evaluated and large meadows and areas of non-host will be mapped for exclusion from treatment. Heliports and airstrips will be located close to or in the project area. Landings will be away from sensitive areas, such as streams, meadows, floodplains, etc.

Each Forest will assign a project manager to oversee all aspects of the project. Forests can combine operations and assign one project manager for several Forests. The project manager will ensure that all personnel are fully qualified to perform their duties. Project managers will notify military bases when project aircraft may be within or near training routes.

Wind speed and direction, turbulence, air temperature, relative humidity, temperature inversions, rain, visibility, and the presence of moisture on vegetation will be considered prior to spraying. Tolerance guidelines for each of these environmental parameters will be included in the application contract. Contractors are required to meet all Federal and State requirements concerning pesticides and the application of pesticides.

Unlike previous projects, the proposed action identifies protecting only areas of concern. This creates a project that may have a number of small, irregularly shaped, and widely separated treatment areas. As a result, the project logistics will be very complex. It will require using aircraft (such as helicopters) that can negotiate close turns, and turning booms off during some times to avoid application to areas not within the treatment boundaries. It may also require setting up more small temporary helispots, or ferrying longer distances to treat isolated areas. Operation feasibility and safety are a primary concern.

The project manager will place special emphasis on reducing or eliminating the following concerns:

- 1) Spraying outside designated areas.
- 2) Treating designated areas more than once.
- 3) Spraying outside of designated weather parameters.
- 4) Non-uniform coverage of the target area.
- 5) Spraying prior to notification of people recreating or camping, or conducting other activities.

- 6) Fuel and pesticide spills.
- 7) Where operationally feasible, direct application to large forest openings and forest edges will be avoided.

ACCIDENTS

The potential for accidents exist. In general, there are four common causes of accidents during pesticide treatment:

Mechanical Failure

Human Error

Environmental Conditions

Transport and mixing of pesticides

There is always the potential for accidents to occur on this and future suppression projects. The standards and mitigation measures mentioned in this report are designed to prevent or lessen the impact of any future incidents.

AERIAL OBSERVATION

In order to monitor and control pesticide application, treatment aircraft will be accompanied by an observation aircraft staffed with a fully qualified aerial observer. Observation aircraft are integral parts of ensuring areas are treated with pesticides in an effective manner. It is anticipated that GPS guidance systems will be used to control swathing and the proper placement of pesticide. Aerial observers monitor spray behavior, calibration, and serve as a backup to the spray aircraft to aid in locating hazards, avoidance of sensitive areas, and to aid in search and rescue if needed. Inefficiencies exist when observation aircraft are paired with more than one spray aircraft.

SPRAY STANDARDS

Application will be made at 50 –75 feet above the tops of the trees. Average application speed will be about 85 miles per hour and average swath will be 65 to 120 feet; although speed and swath width will vary with application types of application aircraft.

The maximum allowable wind speed for spraying is 8 miles per hour. No spraying will be attempted, and all spraying will cease, if wind speeds are in excess of this standard in the spray block. If the application aircraft is unable to compensate for spray drift caused by wind speeds less than 8 miles per hour, or if wind will cause drift into non-target areas, spraying will be stopped or operations moved to areas with more favorable conditions.

Spraying will not occur when fog or low clouds cover the spray area. Spraying may occur when vegetation is moist but not dripping wet. No spraying will take place when it is raining or if rain is predicted within six hours of spray application.

When humidity drops below 50%, spray drops evaporate before they can reach the target area. To prevent this, no spraying will be conducted when relative humidity is less than 50%.

Treatment will not occur when the air temperature at application altitude is 35°F. or less, or above 70°F. Application altitude is defined as the height of the aircraft above the general forest canopy. If the temperature at application altitude is warmer than the surface temperature (even if less than 70°), the spray tends to “hang” (an inversion has developed). Spraying will stop if this condition occurs. Inversions are not a problem if the application aircraft can work within the cooler air.

In certain instances, updrafts can cause the pesticide to rise. When this condition exists, treatment will stop. This can be a localized phenomena; spraying may continue other, affected another portion of the treatment area.

MECHANICAL OPERATIONS

Application operations will be suspended if any of the following conditions exist:

- Mechanical problems with the aircraft.
- Malfunctioning spray system.
- Communication problems.
- Pilot is not in a functional condition.
- Nonfunctioning meters or equipment on batch truck.
- Leaking or faulty systems on aircraft or trucks.
- Lack of qualified personnel (truck driver(s), observation pilot, aerial observer, ground crews, etc.).

SENSITIVE AREAS AND SITUATIONS

Spraying will be suspended when weather conditions could cause drift into no-spray areas. As much as possible, spraying will be avoided over livestock and areas containing large numbers of people.

The Pacific Northwest Forest and Range Experiment Station will be contacted to determine if long-term research projects are located in proposed treatment areas. If so, the project manager will attempt to satisfy the requests of the experiment station.

ACCIDENT CONTINGENCY PLAN

The project manager will ensure that contingency plans for accidents exist prior to operations. Plans will specify the list of authorities and responsibilities of each agency, participants and contractors, notification procedures, and provisions for search and rescues, spills, and cleanup.

SPILL MANAGEMENT

The objective of spill management is to minimize the possibility of spills by planning and monitoring any operations where pesticides, diesel, jet fuel, or other petroleum-based products are being used. In the event of a spill, contract personnel will take immediate action to correct the problem. These protective efforts will be continuous and progressive; actions are dependent upon the product and the nature of the spill.

PROJECT PERSONNEL RESPONSIBILITIES

Spill plans developed by the contractor will be reviewed by project managers. The project manager, or personnel designated by the project manager, will assist the contractor to meet project objectives. Project personnel will secure an accident area until the contractor completes appropriate control and cleanup actions to protect the environment and to meet Federal and state laws and regulations.

CONTRACTOR RESPONSIBILITIES

Cleanup and disposal of leaks or spills will be the responsibility of the contractor. Cleanup and disposal shall be in accordance with any applicable State laws and regulations. The Forest Service may assist the contractor, but will not assume any contractor responsibilities.

Prior to beginning, the contractor will submit a spill plan, with procedures for cleanup to protect the environment and the safety of workers. The spill plan will indicate that the contractor has the knowledge and ability to minimize the effects of any accidents that might occur. The spill plan must be approved by the appropriate officials before operations begin.

SPILL CONTROL TECHNIQUES

At a minimum, dirt berms may be used to stop the spread of a spill or divert it to less sensitive areas. Spills may be absorbed by dirt, sawdust, newspaper, sweeping compounds, or other suitable material. If an incident occurs, a thorough investigation will be conducted.

PROTECTION OF THREATENED, ENDANGERED, OR SENSITIVE SPECIES

A biological evaluation ("BE") will be completed for all Forest Service actions that could affect threatened, endangered, or sensitive species or their habitat. The BE will determine whether a species or habitat is present in the project area and any potential effects. Mitigation measures or project modification may be necessary to ensure the proposed activity will not adversely affect the recovery of threatened, endangered, or sensitive species.

MONITORING

Spray projects will have a written monitoring plan. The purpose of monitoring is to:

- ▽ Measure project accomplishment, specifically the post-treatment insect populations and foliage protection.
- ▽ Provide timely feedback about the conduct of the operation.
- ▽ Monitor spray deposit in the target areas.
- ▽ Monitor overall treatment effectiveness.

In the event of a pesticide spill into a body of water, water samples and visual observations will be used to monitor pesticide distribution and environmental effects.

PROTECTION OF WILDERNESS VALUES

Several Forest Land and Resource Management Plans contain specific standards and guidelines for management of Wilderness areas. Some of these objectives are:

- To allow indigenous insect and plant diseases to fulfill, as nearly as possible, their natural ecological role.
- To protect the scientific value of observing the effect of insects and diseases on ecosystems and to identify resistant plant species.
- To control insect and plant disease epidemics that threaten adjacent lands or resources.

Generally, Wilderness areas across Washington and Oregon will not be treated to control tussock moth. This is because the moth life cycle suggests that the lack of treatment in Wilderness does not pose a threat to non-Wilderness lands. Therefore, most natural processes will be allowed to continue. However, Forest Plan standards and guidelines do allow treatment in Wilderness areas under certain circumstances. Treatment in Wilderness areas would be allowed if tussock moth infestation threatens municipal watersheds. Additionally, treatment would be allowed where unique ecosystems exist. Each Forest will evaluate their situation to see if treatment is appropriate.

APPENDIX H: HUMAN HEALTH EFFECTS ANALYSIS

AFFECTED ENVIRONMENT

The health and safety of people are influenced by many factors including diet, climate, diseases, contaminants in the soil and water, emotional well-being, and access to medical facilities. This analysis concerns itself with the potential or perceived health effects associated with the Douglas-fir tussock moth and proposed actions. Human health effects include those effects related to the exposure and potential effects of treatment with insecticides, and the effects related to exposure to the Douglas-fir tussock moth.

There are interspersed private lands within the administrative boundaries of the nine National Forests. Recreation sites, special use sites, and general recreation areas are within the analysis area. In addition there are small communities scattered throughout that are in close proximity to National Forests. Forest Service employees often live or work on administrative sites within the National Forest boundaries. People who live in or near areas where there is host type (Douglas-fir and true fir trees) could be affected by the Douglas-fir tussock moth; and people who live near proposed treatment areas could be exposed to treatments. Included could be individuals with allergic reactions, respiratory ailments, or chemical sensitivities; immunocompromised individuals; pregnant women; children; and the elderly. Individuals who work in the forest environment or with trees, who mix or apply the pesticides, or recreate within the forest could be exposed to the Douglas-fir tussock moth or the treatments.

ENVIRONMENTAL CONSEQUENCES

The human health consequences of Douglas-fir tussock moth, *Bacillus thuringiensis* var. *kurstaki*, and TM-BioControl are discussed in this section. An in-depth risk assessment was done for *Bacillus thuringiensis* var. *kurstaki* for the Programmatic Gypsy Moth Environmental Impact Statement (USDA FS and APHIS, 1995), and we incorporate information from that document for this analysis. An in-depth risk assessment has been done for TM-BioControl and this information is used in this analysis. The Gypsy Moth EIS also includes an analysis of Gypchek, which is the gypsy moth nucleopolyhedrosis virus equivalent to TM-BioControl. Some of the analyses for Gypchek used in the Gypsy Moth EIS will be inferred for TM BioControl, as needed. In addition, the Gypsy Moth EIS discusses effects due to the gypsy moth. The gypsy moth (*Lymantria dispar* L.) is closely related to the Douglas-fir tussock moth. Since the gypsy moth often occurs in urban areas and areas where higher populations occur and work, the risk assessments for the Gypsy Moth EIS will take into consideration opportunities for more exposure by a higher number of people than will likely occur with Douglas-fir tussock moth and its proposed treatments.

In the Gypsy Moth EIS, procedures used to assess risks to human health were similar to those recommended by the National Research Council of the National Academy of Sciences. The Gypsy Moth EIS contains analyses of: Hazard Identification, Exposure Assessment, Dose-Response Assessment, and Risk Characterization. We rely on these assessments and adapt the descriptions to better describe the Douglas-fir tussock moth situation as needed, and where additional information is available. The following is a description of the methods used in the Gypsy Moth EIS:

HAZARD IDENTIFICATION

Hazard identification determines whether a particular treatment or the Douglas-fir tussock moth can be associated with adverse health effects and identify the effects that it is likely to induce in those exposed to it. In other words, the hazard identification process for the human health risk assessment involves determining what endpoints an agent is likely to induce in humans for such reproductive and teratogenic effects, carcinogenicity, and irritant effects. The hazard of each treatment and the Douglas-fir tussock moth was examined by reviewing relevant toxicological and pharmacokinetics data from published literature, manufacturer's information, specific information from knowledgeable experts in the field and reliable published anecdotal information on exposed populations. The hazard of inert ingredients or possible contaminants in the insecticides was also considered.

EXPOSURE ASSESSMENT

The exposure assessments determine the dose of an agent to which humans may be exposed, including the magnitude, duration, schedule, and route of exposure; the size, nature and types of populations exposed; and the uncertainties involved in deriving all estimates. Three steps were involved in assessing the population exposures:

1. Describing exposure scenarios
2. Estimating levels in the environmental media, such as soils, water, air, and vegetation
3. Calculating dose rates.

The exposure scenarios selected were based on how the insecticides are applied and the biological, physical, and toxicological properties of both the insecticides and the insect. Depending on the insecticide properties and application method, the following were considered: oral, dermal, inhalation, or combined exposure to the insecticide or gypsy moth (i.e. Douglas-fir tussock moth); exposure of people living in or visiting treated areas and by project workers; and acute, subchronic, or chronic durations of exposure.

Three types of exposure scenarios were considered: routine, extreme, and accidental. For routine exposures,

assumptions were made that the recommended application rates are used, that recommended safety precautions are followed, and that the estimated model values, such as food or water consumption rates and skin surface area, are based on the most likely activities and circumstances that increased the estimate of exposure. For extreme exposures, assumptions were that recommended procedures and precautions were not followed and that exposure parameters were based on different activities and circumstances that increased the estimate of exposure. For accidental exposures, the assumption was some form of equipment failure or gross human error occurred. Not all scenarios were used in each analysis. The decision to use a particular scenario was based on its applicability to the agent being assessed and the need to encompass uncertainties in the exposure.

The Human Health Risk Assessment (Appendix F of the Gypsy Moth EIS) also considered potential exposed or absorbed doses for individuals of different age groups, such as adults, young children, and toddlers. Values such as body weights and food consumption weights were taken from standard sources (U.S. EPA 1988c, 1989b cited in USDA FS and APHIS GM EIS, 1995).

DOSE-RESPONSE ASSESSMENT

A dose-response assessment, which is only done in connection with human health, is the response of characterizing the relationship between a known dose response of an agent, and the incidence of an adverse effect in an exposed population. It involves estimating the incidence and severity of an effect as a function of dose or exposure to the specific agent, the intensity of exposure, the age range during exposure, and other variables that might affect the response, such as sex and lifestyle. Extrapolation from low to high dose and from animals to humans is often required (NRC 1983, cited in the Gypsy Moth EIS).

Two general types of dose-response assessments were conducted in the human health risk assessment. For the most part, a no-observed-adverse-effects-level (NOAEL) and an uncertainty factor were used for the non-carcinogenic effects. For cancer risks, a dose-response model was used.

Quantitative toxicological assessments involve deriving an estimate of the dose level that is unlikely to cause adverse health effects in humans. This dose estimate is called the risk reference value (RRV). It is derived by taking the experimental no effect (or equivalent) dose associated with the most sensitive effect and applying a series of uncertainty factors to adjust for differences between the experimental design and the conditions for which the RRV is being derived.

RISK CHARACTERIZATION

Risk characterization is the process of estimating the incidence of human health effect in a human population under different conditions of exposure represented in the exposure risk assessment (NRC, 1983, cited in USDA FS

and APHIS, 1995). It involved comparing the dose to which humans may be exposed, with the RRV. This comparison produces a hazard quotient, which indicates a level of concern regarding one or more exposure scenarios. Because the RRV represents an exposure that is not expected to cause adverse effects, a hazard quotient of 1 or less would not be cause for concern.

All relevant routes for exposure (mouth, skin, respiratory tract) were considered in deriving a composite hazard quotient. A hazard quotient greater than 1 (dose exceeds the RRV) indicated that an adverse effect might be observed after exposure. In some cases, however, uncertainties associated with the hazard identification and exposure assessment required a qualitative judgment to characterize the risk involved.

CUMULATIVE EFFECTS

Some exposures, especially in workers, may last for several days to several months. In addition, some program activities may be repeated for several consecutive years. Such exposures are referred to as cumulative exposures.

Depending on the specific exposure scenario and the nature of the available data, the consequences of cumulative exposures are assessed in a variety of ways. For carcinogenic effects, total dose is assumed to be related directly to risk. Thus, the consequences of two applications at a given rate would be twice those of a single application.

For toxic effects, concern is triggered by exposures that exceed the RRV. Only a limited amount of most control agents may be applied in a given year. Consequently most exposure scenarios assume maximum application rates. If the RRV is not exceeded by multiple applications at maximum rates, it will not be exceeded by multiple applications at lower rates. The Gypsy Moth EIS considered multiple applications because in cases of eradication, areas are often treated twice or three times. Douglas-fir tussock moth suppression would only involve one treatment on an area, and therefore, the Gypsy Moth EIS assessment will be addressing a more rigorous application than is proposed for the Douglas-fir tussock moth.

CONNECTED ACTIONS

Some individuals may be exposed to several treatment types, either in their job as applicators or because more than one type of treatment or exposure will be used in adjacent areas. Such exposures are considered connected actions, that is, one or more actions that an individual may take that could affect the individual's risk to the agents used to control the Douglas-fir tussock moth. In addition, individuals are exposed to a multitude of chemicals and biological organisms every day in foods, medicines, household products, and other environmental chemicals.

Exposure to multiple chemical or biological agents could lead to interactions. For most of the agents under review, relatively little information pertaining to this issue is

available. Available information is included in the risk characterization.

1. EFFECTS DUE TO THE DOUGLAS-FIR TUSsock MOTH

HAZARD IDENTIFICATION

Douglas-fir tussock moth outbreaks are associated with an adverse human health effects called "Tussockosis". The urticating hairs of the Douglas-fir tussock moth cause an allergic reaction characterized by skin irritation, eye irritation, and respiratory tract irritation. Individuals who work in the woods, such as loggers had significantly higher reactions (83%); two other worker groups, forester and forester assistants studying and working in the woods, and mill workers also had significant reaction (44% and 41% reactions, respectively). Individuals who have sensitivities and allergies to other insects are more sensitive than others are to DFTM (Perlman, et. al, 1976). Studies indicate that DFTM hairs are at least as potent, and possibly more potent irritants than gypsy moth (SERA, 1999). Therefore, the hazard risk for the assessment of gypsy moth on human health represents similar, if not slightly less direct effect on people than the Douglas-fir tussock moth.

The DFTM may also be a nuisance, although this issue may not constitute an easily measured health effect. Fewer people would be exposed than occur in urban areas. In 1998, many people were inconvenienced by the presence of millions of larvae feeding on trees within the developed sites and raining fecal material onto visitors and their property during the outbreak in Kings Canyon National Park in California (USDI, 1999).

EXPOSURE ASSESSMENT

During non-outbreak years the Douglas-fir tussock moth does not represent a hazard because it occurs at very low levels. During outbreaks, the combinations of insect frass, loss of shade, and the large numbers of caterpillars may become a major nuisance in those areas where people are living, working or recreating. The localized variability of the outbreaks makes the potential for human exposure difficult to quantify. If people live or are in an area with an outbreak however, their chances of coming in contact with larvae are greatly increased. Estimates for exposure analysis are approximately 300,000 larvae/acre for an outbreak (SERA, 1999). These estimates were based on Douglas-fir tussock moth population levels (rated at an average of 50 larvae per 1000 sq. inches of foliage) during the outbreak in Sequoia/Kings Canyon National Park in 1997. As the density of the caterpillar populations within an area increases, the risk of exposure to the insects in that area is likely to increase. This analysis focuses on sites on National Forest lands, so people most likely to be exposed to DFTM in the analysis areas are those who are working, visiting or recreating, or otherwise temporarily located within an infested area. Except for a few exceptions, most people will not be living within the analysis sites.

EXPOSURE-RESPONSE ASSESSMENT

In the Gypsy Moth EIS, two kinds of exposure-response assessments were possible. The one most similar to an assessment for DFTM is the approach based on the standard RRV, or exposure level associated with no adverse effects in an exposed population. For the RRV, the NOAEL (no-observed-adverse-level) was considered to be the incidence of skin reactions in a community that had low exposure, when compared to that of a community with high exposure. Severe gypsy moth infestations may be associated with 20%-30% of the incidences of skin rashes that are sufficiently severe to cause members of the general public to seek medical attention. Perlman, et. al. (1976) examined 227 workers with the primary signs and symptoms of Douglas-fir tussock moth. The extra risk for mill workers, forestry workers, and loggers was 24%, 28%, and 78%, respectively. For mill workers and forestry workers, these rates are similar to those reported for gypsy moth. For loggers, the 78% is substantially higher than the other two groups, or rates in the general public from gypsy moth (SERA, 1999). Loggers represent the extreme opportunity for contact with high amounts of insect hairs. The forestry workers probably represent the more likely level of opportunity for reaction from individuals recreating or working in an infested area. Based on these results, the exposure-response assessment for gypsy moth developed in the Gypsy Moth EIS can be used as representative of the exposure-response for the Douglas-fir tussock moth.

RISK CHARACTERIZATION

Exposure to DFTM caterpillars is associated with skin, eye, and respiratory effects in humans. The presences of larvae and defoliation may cause stress, especially to individuals in recreation areas, or whose job requires them to work in an infested area. Skin reactions may be considered to be the most sensitive of all health effects, that is, if skin irritation is not observed, other health effects are not likely.

Risk of human exposure is associated with the probability of coming in contact with the larvae or cocoons and eggs masses of the Douglas-fir tussock moth. Because caterpillar density and human behavior are related to exposure, two types of probabilities are of concern: 1) the chance that an individual will have an adverse response if they come in contact with DFTM, and 2) for a given level of insect population, the proportion of the population likely to be affected. The Gypsy Moth EIS characterizes four gypsy moth population levels – sparse, moderate, heavy and extreme. For Douglas-fir tussock moth, outbreak levels are most likely comparable to the heavy and extreme scenarios. The gypsy moth, hazard quotients for exposure to the four population densities were all greater than 1, indicating that exposed individuals would likely have some adverse response; and the more likely the exposure, the greater was the chance of having a reaction, and the likelihood of exposure increased with higher insect population densities.

A different risk estimate represented the proportion of workers and similarly exposed individuals who would likely have adverse health reactions after a significantly high exposure. An estimate of 25% approximates the groups of individuals who developed skin rashes after confirmed contact with the gypsy moth. Perlman, et. al. (1976) reported 41% -83% reaction to DFTM with and adjusted rate of extra risks of 24% for forestry workers.

CUMULATIVE EFFECTS

Two types of cumulative effects were considered in assessing the consequences of gypsy moth exposure. Of those, repeated exposures in one season are most appropriate for Douglas-fir tussock moth. Cumulative effects over more successive years is less likely because of the rapid increase and decline of the tussock moth population and the length of time between outbreaks. Some individuals may become more sensitive to the tussock moth over repeated exposures during the course of a season, but not over exposure over several seasons.

CONNECTED ACTIONS

There are no known data that can be used to assess the consequences of connected actions involving the various activities for the proposed projects. TM-BioControl contains Douglas-fir tussock moth larvae parts and may cause irritant effects similar to those caused by the DFTM caterpillars. Exposure to both the DFTM caterpillars and TM BioControl may be additive, although there are no data showing that this occurs.

GROUPS AT RISK

Young children appear to exhibit more reactions than adults do to gypsy moth. Whether this was because they are more sensitive, or because they spend more time outdoors is not known. If it is because they are more sensitive, then it is assumed that reactions would be similar for DFTM. If they are more sensitive than adults are because they spend more time out of doors, then for DFTM the reactions should be similar for adults and children in most cases, since children would be accompanying and recreating with adults visiting National Forest sites.

2. EFFECTS DUE TO *BACILLUS THURINGIENSIS* VAR. *KURSTAKI* (B.T.K.)

The Gypsy Moth Environmental Impact Statement provides an in depth risk assessment for *Bacillus thuringiensis* var. *kurstaki*, which we incorporate and adapt as needed for the Douglas-fir tussock moth.

HAZARD IDENTIFICATION

Human exposure to B.t.k. provides little cause for concern about health effects. For example, in its review of technical information submitted by manufacturers if B.t.k. formulations, the U.S. EPA concluded that B.t.k. is not a human pathogen, but can cause irritation or inflammation. More recently, the British Columbia Ministry of Health

concluded that B.t.k. is specific to Lepidopteran caterpillars and does not pose a threat to humans.

Under usual conditions, B.t.k. formulations do not pose a substantial risk to workers of the public. In drawing this conclusion, a clear distinction must be maintained between the microorganism B.t.k., and commercial preparations of it. As with any preparation containing microorganisms, potential concerns include pathogenicity, persistence of the microorganism in the human body, the genetic stability of the microorganism in the environment, and the ability of the microbial agent to interact with other microorganisms. As a complex mixture of chemicals, formulations may have toxic properties that are unrelated to the presence of B.t.k. For example the available data regarding human exposure to B.t.k. formulations suggest that they cause eye, skin, and respiratory tract irritation. It is not clear, however, if these effects are caused by the microorganism itself or other parts of the formulations.

To ensure that no formulations contain pathogenic contaminants, the U.S. EPA requires that manufacturers implement quality control measures to detect either contamination with other microorganisms or changes from the characteristics of the parent B.t. strain. For example, batches are tested and rejected if potentially hazardous bacteria exceed established levels that have been reviewed and accepted by the U.S. EPA.

The most common effects from exposure to B.t.k. are eye, skin, and respiratory tract irritation, which have been seen in experimental animals and in exposed workers.

Additional recent accounts report similar eye and skin irritations and hypersensitivity (cited in Anonymous, 1999) similar to reports cited in the Gypsy Moth EIS. In one report, a doctor in France reported isolating a strain of B.t.k. from a severe wound in a soldier in Bosnia. This was later identified as a strain of B.t. known as HD-34, and when an automated medical analysis was conducted, it seemed to show the bacterium was *B. cerus*, that produces a toxin, which ruptures cell membranes (McKenzie, 1999). Human health factors were monitored during and following multiple applications of B.t.k. in New Zealand in 1997, and an in-depth human health monitoring program was conducted in British Columbia in 1999. Both studies concluded that in cases where B.t.k. isolates were recovered, on no occasion were the B.t.k. isolates associated with disease, and no change in health status could be linked to the spray program (Public Health Care Service, 1997; Capital Health Region Office, 1999). In all cases where B.t.k. was isolated, it was determined to be a contaminant (Public Health Care Service, 1997). These findings do not refute other research and findings, that B.t.k. is not a human pathogen. These references are generally similar to those cited by the Gypsy Moth Human Health Assessment and we conclude that they would not alter anticipated impacts or consequences.

Despite the large volumes of B.t. based products that have been used for a number of years, and in some instances, directly over urban and highly populated areas, there are

very few case reports of human illness due to B.t.k. or other *Bacillus thuringiensis* subspecies. Even in these isolated cases, the precise role of the B.t.k. was unclear. Previous surveillance in Oregon, Washington, Vancouver, and New Zealand either found no clinical cases associated with B.t.k. or found no cases where B.t.k. could neither be confirmed nor refuted as a contributing factor to a person's disease (Capital Health Report, 1999).

Concern that B.t. would mutate into *B. anthracis* (the cause of anthrax in animals and man) initiated several studies that showed that there was no indication of mutation (Saik, et.al., 1989). B.t.k. has been used extensively for almost 40 years, and to our knowledge there has been no reported case where B.t.k. has mutated into another organism.

The composition of inert (inactive) ingredients in the commercial formulations of B.t.k., and their significance to public health is a matter of concern for the general population. These were evaluated in both the Gypsy Moth EIS and the Human Health Surveillance Report in British Columbia. These intentionally added inert ingredients, also known as formulants. They serve a variety of purposes and include stickers and binders to help the spray remain on the vegetation, and products to reduce contamination by other yeasts and bacteria. Although the identities and quantities of the inert ingredients are proprietary information, all of the inert ingredients in Foray formulations produced by Abbott Laboratories are on the U.S. EPA Lists 3 and 4. Inclusion in list 4 indicates that the inerts are generally recognized as safe (the GRAS list), and inclusion in list 3, indicates that there is insufficient information to classify them. One document on Foray 48B does provide some specific information that can be disclosed. Foray 48B is a mixture of B.t.k. and fermentation materials, which comprise almost 90% of the product. The added inerts (that is, those that are incidental to the fermentation process) include materials to inhibit bacterial or fungal contaminants. Compounds could include residues of leftover bacteria food such as starches, glucose or sucrose, proteins, water and a sticking agent. Other food grade materials such as sodium hydroxide or potassium phosphate may also be found in basic ingredients (Capital Health Region Office, 1999). These additives are approved for use in foods both in the U.S. and Canada. No volatile solvents are used in Foray 48B. All inerts have been reviewed by both the U.S. EPA and by various agencies in Canada (USDA FS and APHIS, 1995; Capital Health Region Office, 1999). In addition, the Oregon Department of Human Resources reviewed the complete formulation of Foray 48B and determined that "... exposure to the ingredients in the Foray 48B formulation are unlikely to pose a public health threat to populations exposed to spray in eradication programs" (Flemming, 1993, cited in the Gypsy Moth EIS, 1995). In preparation of the risk assessment for the Gypsy Moth EIS, U.S. EPA files on product chemistry were reviewed for all B.t.k. formulations and the individual components do not appear to be highly toxic agents. Some components are complex mixtures of nutrients that have not been fully characterized.

EXPOSURE ASSESSMENT

The aerial and ground methods of spraying B.t.k. suggest that the likeliest routes of exposure by the general public are by mouth, skin, and respiratory tract. Accidental exposures through the eyes may occur in workers.

Data were collected on exposure of workers and the public to B.t.k. from aerial sprays. Worker exposures to B.t.k. were substantially the same for pilots, aerial observers, a safety officer, or a security guard. Exposures for all but one card checker were in the general range of other aerial applicators. It is possible for weather observers or card checkers to have direct contact with the spray in the field.

Exposure of card checkers to B.t.k. varied considerably between studies. Substantial differences may be due to work practices, although the studies used different B.t.k. formulations and batches, and different analytical methods. The levels of viable B.t.k. spores in batches from the same manufacturer may vary by a factor of at least 50. Thus, the levels of exposure between studies are not necessarily comparable.

During ground spraying workers can be exposed to high levels of B.t.k., with concentrations ranging from 0.2 to 15.8 million colony-forming units per cubic meter of air (Cook, 1994, cited in Gypsy Moth EIS, 1995). The maximum cumulative exposure for these workers was 720 million colony-forming units and the lowest cumulative exposure was 5.4 million colony-forming units. Variables that influence actual exposure rates are concentration of the B.t.k., specific application methods, duration of exposure, and the type of job.

In an extensive human health exposure study conducted in British Columbia, air, nasal, fruits and vegetables in local markets, and clinical isolates from bad infections were sampled, both before and after spray and within and outside of the treatment areas. The frequency of B.t.k. HD-1 increased significantly, but no health effects were observed to be associated with this increase (Capital Health Region Office, 1999).

DOSE-RESPONSE ASSESSMENT

For workers, skin contact with B.t.k. suspended in air is the primary exposure concern. It is the likeliest exposure for ground workers. Reported responses in exposed workers were characterized as irritation to the skin, eyes, and respiratory tract. Low level cumulative exposure (ranging from 5.4 million to 100 million colony form units) resulted in each worker reporting 1.5 symptoms – about twice the response rate of 0.8 symptoms per person) in the control group. Using this information and standard methods and uncertainty factors to calculate risk reference values, the RRV derived for workers was determined to be 0.2 million colony units.

The effects covered by this dose-response assessment are of minor clinical significance. The number of workdays lost by ground workers was no greater than that of the control group (Cook, 1994 cited in the Gypsy Moth EIS).

No dose response relationship could be proposed for workers on aerial application projects. In monitoring studies, however, exposure of aerial workers to B.t.k. was only slightly higher than that of the general public (Elliott and others, 1986, 1988 cited in the Gypsy Moth EIS, 1995).

Two detailed epidemiology studies were available on exposure of the public to B.t.k. One study in Oregon involved the aerial application of Dipel at a rate of 16 billion international units (BIU) per acre (39.5 BIU/ha) over about a quarter of a million acres with a human population of about 40,000. One study in British Columbia involved the aerial application of Foray 48B at a rate of about 20 BIU/acre (49 BIU/ha). Neither study detected any adverse effects in the exposed populations. In addition, a surveillance program by a group of family physicians noted no substantial difference in the reports of symptoms that might be associated with B.t.k. exposure within and outside of the spray area (cited in the Gypsy Moth EIS, 1995).

The doses in both of these studies were regarded as no-observable-effect levels (NOEL), since neither study detected any effects in exposed populations. Since both studies covered large numbers of individuals in the general population, an uncertainty factor was not used. The higher NOEL of 20 BIU/acre was taken directly as the RRV for the general public. On the basis of both the available epidemiology studies as well as the long history of use, no hazard has been identified for members of the general public exposed to B.t.k. formulations. Some individuals are likely to be considered part of a sensitive subgroup, which may not have been represented in the studies.

RISK CHARACTERIZATION

Commercial formulations of B.t.k. would be applied both aerially and by ground sprays in areas where people may recreate and work, and to a lesser extent live, and exposure of both workers and the general public are a concern. A large and compelling body of human experience, as well as many toxicity studies on experimental mammals, indicate that neither B.t.k. nor its commercial formulations are highly toxic or infectious.

Aerial Sprays

For aerial application crews and the general public, the hazard identification is essentially negative, that is, no adverse effects can be attributed to B.t.k. exposures during aerial application. Epidemiology studies indicate that application rates of up to 20 BIU/acre have not been associated with adverse effects in humans: consequently this value was adopted as the RRV. The hazard quotient is 1 for exposure to 20 BIU/acre: however the risks associated with exceeding the RRV cannot be directly characterized. No epidemiology studies have been conducted at the maximum application rate of 40 BIU/acre. Thus, the hazard quotient is 2 for this application rate. Application rates for B.t.k. for the

Douglas-fir tussock moth will be between 16 and 24 BIU/acre.

Ground Sprays

Exposure of workers to commercial formulations of B.t.k. during ground application is likely to cause transient and relatively minor irritation of the skin and respiratory tract. Dose-response relationships of these effects have been demonstrated (Cook, 1994 cited in the Gypsy moth EIS, 1995). Hazard quotients ranged from 30 to 3600, depending on the specific exposure levels: low, medium, or high. Hazard quotients greater than 1 do not necessarily indicate severe health effects are anticipated for ground workers. The health effects to ground workers associated with the very large hazard quotients, based on exposures reported (Cook, 1994 cited in the Gypsy Moth EIS, 1995), can be classified as relatively mild and transient. Exposure of the public to ground sprays is similar to aerial sprays, therefore, the hazard quotients are the same.

Uncertainties

Uncertainties in the risk characterization for B.t.k. include these: (1) the complex and variable nature of B.t.k. and its formulations; (2) the toxic agent or agents associated with the irritant effects to the eyes, skin, and respiratory tract have not been clearly identified; (3) the dose-response assessment for ground workers is based on only one formulation of B.t.k.; and (4) the most meaningful measure of human exposure to B.t.k. formulations cannot be determined. That is, is it more meaningful to look for a threshold level below which no effects occur or to take a conservative approach and use the cumulative exposure per person? The risk assessment used the more conservative approach.

The inability to identify clearly the ingredient or ingredients in B.t.k. formulations associated with potential adverse effects complicates the analysis. In addition, because the dose-response assessment is specific to monitoring data from a specific study, the data (in terms of the colony forming units) from one study may not be directly analogous to the data from other studies. This imposes substantial limitations on the characterization of risk. These uncertainties notwithstanding, the overall quality of the data on B.t.k. can be categorized as being moderate to good.

CUMULATIVE EFFECTS

The cumulative effects associated with the application of B.t.k. formulations must consider both the residual exposure to B.t.k. and formulation products after a single application as well as the effects of multiple applications in a single season and over several years. Monitoring data from the Oregon study (Elliott and others cited in the Gypsy Moth EIS, 1995) demonstrate that levels of B.t.k. in the air can be detected several days after spraying. Because the dose-response assessment is based on epidemiological studies, it implicitly considers this type of cumulative effect. The effects of multiple exposures over several years, however, cannot be directly assessed.

Agrichemical and Environmental News (Anonymous, 1999) cited one study that indicated a greater prevalence of hypersensitivity to B.t. among the most highly exposed workers. Most individuals do not fall into the category of "most highly exposed", and, for the most part, as indicated by a study in British Columbia, effects that may occur are likely to be transient (Cook, 1994; Nobel and others, 1992 cited in the Gypsy Moth EIS, 1995). In this respect, cumulative effects from spray programs conducted over several years would not be anticipated. In the Douglas-fir tussock moth project, the only group likely to be exposed to successive years of exposure to B.t.k. would be workers who happened to work on successive projects in different areas.

CONNECTED ACTIONS

Workers or members of the public who are exposed to either aerial or ground sprays of B.t.k. will also be exposed to the Douglas-fir tussock moth and may be exposed to TM-BioControl as well. No data were available to suggest that risks posed by these other agents will affect the response, if any, to B.t.k. formulations. Similarly, exposure to chemicals in the environment may affect the sensitivity of individuals to B.t.k. Again, no data were available to permit an assessment of such interactions.

GROUPS AT SPECIAL RISK

B.t.k. formulations contain viable microorganisms; therefore, it is reasonable to suggest that immunocompromised individuals may be at special risk. A study in British Columbia, however, did not find immunocompromised individuals to be at special risk due to a gypsy moth spray program (Nobel and others, 1992 cited in Gypsy Moth EIS, 1995). Immunocompromised mice cleared injected B.t.k. from their systems without illness, as did immunocompetent mice (Siegel and others, 1987 cited in Gypsy Moth EIS, 1995).

Little information is available on groups with special sensitivities such as allergies or chemical sensitivities to B.t.k. formulations. In British Columbia, only a weakly positive relationship was noted in the incidence of irritant effects between ground workers with and without a history of asthma, seasonal allergies, or eczema (Cook, 1994, cited in Gypsy Moth EIS, 1995). Asthmatic children both within and outside of the spray zone were monitored before, during and following aerial applications of B.t.k. People with asthmatic children in the spray zone did not have any more symptoms than did those outside of the spray zone, either before or after treatment. One five year old boy experienced increased problems, however, this could not be directly linked to the spray (Capital Health Region Office, 1999).

3. EFFECTS DUE TO TM-BIOCONTROL

A separate risk assessment was conducted for TM-BioControl (SERA, 1999). The Gypsy Moth Environmental Impact Statement provides a risk analysis of Gypchek, the nucleopolyhedrosis virus (LdNPV)

specific to gypsy moth. The same format is used, and much of the information for these two products is similar.

Douglas-fir tussock moth nucleopolyhedrosis virus (OpNPV) occurs naturally and is responsible for the collapse of most of the DFTM outbreaks. There are two similar nucleopolyhedrosis viruses that occur: one, the multicapsid virus, appears to be the most virulent, and it was this virus that was used in the development of TM-BioControl. TM-BioControl is a powdered formulation of the virus, and was developed and registered by the USDA Forest Service for control of Douglas-fir tussock moth. The powdered formulation of TM-BioControl is produced by the *in vivo* culture of infected DFTM larvae. As a result, the major portion of the formulations consists of ground tussock moth caterpillar parts (about 89%). The powdered TM-BioControl is mixed with water, molasses, and a whitening agent (to protect the virus from the effects of solar radiation) and applied at the rate of 1-2 gallons per acre. In some instances, TM-BioControl may be mixed with Carrier 038, which is a premixed carrier. All of the components of Carrier 038 are on the EPA list 4 (GRAS – Generally Recognized As Safe) and all are exempt from residue tolerances under Chapter 40 of the Code of Federal Regulations, Section 180.1001. Most of the components are natural products, many of which are complex and not chemically defined.

HAZARD IDENTIFICATION

This assessment is based on human data, as well as data on experimental mammals. The typical endpoints were addresses. In addition, for biological control agents, additional endpoints of particular concern are infectivity (the ability to survive in an organism) and pathogenicity (the ability to grow in and damage an organism). For TM-BioControl, another area of concern is the potential impact of insect parts of the Douglas-fir tussock moth, which are known irritants, and allergens in humans. Several moth larvae, including Douglas-fir tussock moth have hairs that can cause skin, eye, and respiratory irritation in humans. Studies of humans exposed to DFTM infestations indicate that the prevalence of these effects may range from approximately 25% to 75%.

Most of the available mammalian toxicity data on TM-BioControl was generated in the mid-1970's as part of the registration process and involved only assays for acute toxicity and infectivity/pathogenicity. Most of these studies involved relatively small numbers of animals and assay for only a limited number of effects. Single oral (gavage) doses of 3160 and 10,000 mg/kg caused no mortality, overt signs of toxicity, or gross pathological changes in rats. Injections of 500 mg/kg of TM-BioControl into the abdomen of mice were fatal within 4 hours of dosing. No effects were seen after injections of 5 or 50 mg/kg. The relatively rapid death of the mice suggests that the mortality was not attributable to infectious bacterial contamination.

TM-BioControl is known to cause skin, eye, and respiratory tract irritation. The available human data

regarding the effects of exposure due to DFTM larvae suggest that the irritant effects are probably due to the occurrence of insect parts in the TM-BioControl formulation. In a standard assay for eye irritation – 0.1g or 100mg in the eyes of rabbits – moderate eye irritation was noted over a 28 day post-exposure period. At a much lower dose, 3.0mg per eye, slight and transient conjunctival irritation was noted with full recovery after 48 hours. A comparison of exposure studies involving undiluted formulations of TM-BioControl and Gypchek indicates that of the two biological control agents, TM-BioControl is a stronger eye irritant.

EXPOSURE ASSESSMENT

In the re-registration of both TM-BioControl and Gypchek, the U.S. EPA determined that formal exposure assessments for the general public and workers were not required because of the lack of any apparent hazard of systemic toxic effects and because the use of TM-BioControl will not substantially increase ambient levels of both NPV and insect larval parts. Based on calculations presented in the TM-BioControl Risk Assessment, it appears the treatment of a severe Douglas-fir tussock moth infestation with TM-BioControl would increase the environmental levels of NPV by about 3% or less. In addition, the use of TM-BioControl to prevent a severe infestation would reduce eventual exposures to both the virus and the insect larvae.

The application rate for TM-BioControl is 6.84×10^{12} PIB's (poly inclusion bodies) per acre. In the production of TM BioControl, the average yield is 6.7×10^8 PIB's per larvae. Thus the number of larval equivalents at the nominal application rate is about 10,000 larvae/acre. This is an overestimate since it does not consider the removal of insect parts during the production of TM-BioControl. By comparison, the number of larvae during an infestation averaging 50 larvae per 1000 square inches of foliage would correspond to about 300,000 larvae per acre. Thus treatment during a severe infestation would increase exposure to the larvae by only about 3%. Treatment of an area with a lower infestation rate would reduce exposure by inhibiting the increase in the larval population by a substantial amount with a subsequent reduction in OpNPV exposure.

DOSE-RESPONSE ASSESSMENT

As with the exposure assessment, there is no basis for conducting a dose-response assessment for systemic toxic effects because there no systemic toxic effects can be qualitatively identified for plausible routes of exposure (i.e. dermal, oral, or respiratory). TM-BioControl may cause skin and eye irritation and these endpoints are of concern, at least, for occupational workers.

In the re-registration of TM-BioControl, the U.S. EPA used data on Gypchek to assess some of the possible risks of exposure to TM-BioControl. Based on an eye irritation study using Gypchek at twice the concentration of a typical field application solution (2X), the U.S. EPA judged that both Gypchek and TM-BioControl would not cause eye

irritation at the field dilutions (1X). Available data on the technical grade formulations (i.e. undiluted formulations) suggest that of the two biological agents, TM-BioControl is a somewhat stronger eye irritant.

RISK CHARACTERIZATION

There is no basis for asserting that workers are subject to any risk of systemic adverse effects in the use of TM-BioControl. Nonetheless, workers involved in the mixing of TM-BioControl will be exposed to the undiluted formulation and there is potential for skin, eye, and perhaps respiratory tract irritation. Even in the application of field dilutions of TM-BioControl, it would be prudent for workers to take reasonable measures and use personal protective equipment to limit the potential for introducing either undiluted formulation, or field dilutions into the eyes.

Infestations of the Douglas-fir tussock moth tend to occur in relatively remote areas and members of the general public are not likely to be exposed to TM-BioControl in the treatment of such infestations. If members of the public were exposed to a spray of TM-BioControl, the primary concern would be the insect parts in the formulation. Because application of TM-BioControl will not substantially increase ambient exposures to either OpNPV or the insect parts, and because TM-BioControl will, over the longer term, reduce exposures to OpNPV and the Douglas-fir tussock moth, the use of TM-BioControl may be judged as beneficial rather than potentially detrimental to members of the public.

CUMULATIVE EFFECTS

There is a low apparent risk associated with one application of TM-BioControl. Because of the fast acting nature of the virus, the same area would not be treated more than once either during the same year or in successive years, and repeated exposure over one or more spray seasons is not expected. Because TM-BioControl contains Douglas-fir tussock moth parts, and individuals may have repeated exposures to tussock moths themselves during one season, there may be a cumulative effect, however, it is very likely insignificant in the context of any cumulative effect that may occur from repeated exposures to the caterpillars themselves.

CONNECTED ACTIONS

Workers or members of the public who are exposed to either aerial or ground sprays of TM-BioControl will also be exposed to the Douglas-fir tussock moth and may be exposed to B.t.k., as well. No data were available to suggest that risks posed by these other agents will affect the response, if any, to TM-BioControl formulations. Again, because TM-BioControl may cause irritant effects similar to those caused by the Douglas-fir tussock moth, exposure to both caterpillars and TM-BioControl may have a very slight additive effect. However, this assessment is speculative.

The available data suggest that immunocompromised animals were not at increased risk from Gypchek, and it is assumed that this applies to TM-BioControl as well. By analogy to the human health effects from exposure to tussock moth caterpillars, individuals with pre-existing allergies may be at greater risk of effects from TM-BioControl.

COMPARISON OF SUMMARY AND RISK ASSESSMENTS

The 1995 Gypsy Moth EIS compares the assessments for Gypsy Moth, B.t.k., and the gypsy moth virus. The comparison generally holds true for Douglas-fir tussock moth as well. The assessment addresses the risks to workers and the general public to the treatment options. In addition, the risk assessment considered the potential adverse human health effects from exposure to Douglas-fir tussock moth, because the tussock moth causes adverse health effects and these must be considered in the assessment of any treatment strategy.

In this comparison, the Douglas-fir tussock moth, B.t.k., and TM-BioControl all cause the same general types of effects: skin, eye, or respiratory tract irritations. These effects are not life threatening or debilitating and are reversible.

In a quantitative comparison, the Gypsy Moth EIS developed a hazard quotient for each treatment as well as the caterpillar itself. On a scale from .0001 to 10,000, the value of 1 or less indicates no effect and a value greater than 1 indicates some level of effect. Based on similarities, it is assumed that the same values developed for the gypsy moth virus and the gypsy moth itself are similar to those that could be expected from the Douglas-fir tussock moth and it's virus, and are applied accordingly.

Under routine conditions of exposure, the only agent likely to cause a substantial number of adverse health effects is the Douglas-fir tussock moth. Under extreme conditions, the use of B.t.k. may be associated with some irritant effects in some members of the public.

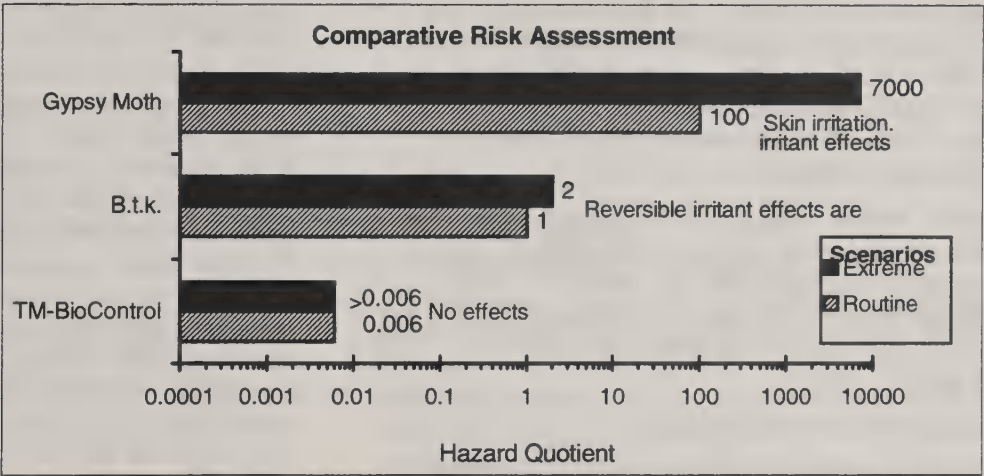


Table H-1: Qualitative Comparison of Risk Assessments

AGENT	PUBLIC	WORKERS
Douglas-fir tussock moth	In moderate or severe infestations, rashes or other adverse skin reactions will be prevalent, most likely in children, and those spending time out of doors near an infestation. Approximately 25% to 40% of the public could have reactions to DFTM.	Approximately 41% to 75% of the workers, working either within the infested areas, or on a project, will exhibit reactions such as skin, eye, and respiratory irritations.
B.t.k.	If exposed to the direct spray, some individuals are likely to have minor irritation of the skin, eyes, or respiratory tract. Pathogenic effects are not likely, even in immunocompromised individuals. Allergic responses are conceivable.	Ground workers may have transient irritation to the eyes, skin, and respiratory tract unless methods are developed to reduce exposures. Aerial workers may develop such effects during prolonged periods of spraying.
TM-BioControl	Irritation of the eyes, skin, and respiratory tract are possible but the likely-hood of such effects cannot be assessed because of limitations in the availability of toxicity and exposure data.	Irritation of the eyes, skin, and respiratory tract are more likely in workers than in the general public because exposure will be higher. As with the public, the likelihood of such effects cannot be assessed.

NO ACTION ALTERNATIVE

In this alternative, no areas would be treated; and no individuals would be exposed to the effects of B.t.k. or TM-BioControl. Individuals recreating and working in infested areas would be exposed to the irritant effects of the Douglas-fir tussock moth. Based on previous data, approximately 25%-40% of the public and 41% to 75% of the workers will experience reactions to the tussock moth larvae.

PROPOSED ACTION

This alternative identifies treating specific areas of concern. Some areas would be treated with TM-BioControl and some would be treated with B.t.k. Many of the proposed treatment areas are fairly remote and removed from the general public, and for the most part, the general public would not be exposed to the treatment. Some areas such as campgrounds and administrative sites are included, and should individuals from the general public be in these areas during direct aerial application of either of the treatments, some may experience transient skin, eye, or respiratory tract irritations. Workers and employees living within the treatment area will have a higher level of exposure.

Because this alternative does not propose to treat all of the potentially infested areas, and none of the adjacent state or private lands which may be infested, individuals, either general public or workers within these untreated infested areas will be exposed to the effects of the Douglas-fir tussock moth.

EXPANDED PROTECTION ALTERNATIVE

This alternative proposes to treat the areas of concern in the Preferred Alternative plus more of the infested general forest areas. More areas will likely be treated with B.t.k.

As with Preferred Alternative, many of the proposed treatment areas are fairly remote and removed from the general public, and for the most part, the general public would not be exposed to the treatment. Some areas such as campgrounds and administrative sites are included, and should individuals from the general public be in these areas during direct aerial application of either of the treatments, some may experience transient skin, eye, or respiratory tract irritations. Workers will have a higher level of exposure.

This alternative proposes to treat more, but not all of the potentially infested areas, and none of the adjacent state or private lands which may be infested. Individuals, either general public or workers, within these untreated infested areas will be exposed to the effects of the Douglas-fir tussock moth.

TM-BIOCONTROL ONLY ALTERNATIVE

This alternative proposes to treat the same areas as the Preferred alternative, but with TM-BioControl only. Many of the proposed treatment areas are fairly remote and removed from the general public, and for the most part, the general public would not be exposed to the treatment. Some areas such as campgrounds and administrative sites are included, and should individuals from the general public be in these areas during direct aerial application of TM-BioControl, some may experience transient skin, eye, or respiratory tract irritations. Workers and employees living within the treatment area will have a higher level of exposure. Since the amount of TM-BioControl is limited, it is possible that some infested areas may not be treated. Individuals in these areas would be exposed to effects of the Douglas-fir tussock moth.

APPENDIX I: MONITORING

GENERAL

The Land and Resource Management Plans of each of the Forests affected by this document require monitoring of specific items within various program areas. The involved Forests produce an annual monitoring report that describes compliance with standards and guidelines, Forest direction, progress in moving lands to a more desired condition, and accomplishments. The various monitoring categories for each of the Forests are not repeated in this document however; interested parties may be able to receive these monitoring reports through the Forest(s) of interest. The monitoring items listed below are additional items because of site-specific analysis contained in this document.

Monitoring for the Douglas-fir tussock moth suppression project will have two objectives:

- 1) Monitor the application and conduct of the project itself.
- 2) Monitor the effectiveness of the treatment in achieving the objectives of the project.

APPLICATION

To a significant degree, the success of a project is based on the appropriate application of the insecticide - both in timing and in getting the spray to the target area. Timing is critical because TM-BioControl and B.t.k. have to be ingested by the caterpillars in order to be effective. The following aspects will be monitored to assure correct timing:

- ✓ Bud development – Newly emerged Douglas-fir tussock moth larvae feed first on the tender foliage of the new growth. Therefore, it is important to ensure that as many of the new needles are exposed as possible. Trees will be monitored to assure that bud caps have dropped and new needles are fully exposed.
- ✓ Insect development - The insect must be out and actively feeding on the foliage at the time of application. The ideal stage of the insect for treatment is when the majority of the insects are in the 2nd and 3rd instars. Older instars are actively feeding, but they consume significant amounts of foliage very quickly and the objective of foliage protection would not be achieved. Sample trees will be established throughout the treatment areas and insect development will be monitored on a daily basis.
- ✓ The following aspects will be monitored to assure correct spray deposit:
- ✓ Weather – The one factor that influences spray deposits the most is weather. There are very specific weather parameters that define the spray window. Treating outside of these parameters will jeopardize

optimum application and result in drift off-site. Wind, humidity, and temperature are all factors that will be monitored both through weather forecasts and by weather observers placed in the spray blocks collecting this information on about 15 minute intervals, starting early in the morning before application is to begin and during the time of application.

- ✓ Application – Aerial observers will be flying in aircraft above the spray aircraft. These observers will be monitoring the location and swath characteristics of the spray aircraft as well as height and application. Observers will also monitor the spray characteristics that may be affected by localized weather conditions such as spray drift or rising due to thermal uplifts. They will also be able to monitor for mechanical problems such as clogged spray nozzles that will affect spray deposit. If possible, spray aircraft will be equipped with GPS guidance systems that will assist proper swath widths and spray block boundaries.

TREATMENT EFFECTIVENESS

The primary objective of the project is to prevent defoliation and subsequent tree mortality that will cause significant change in the stand structure or the treated areas. Short-term treatment effectiveness can be monitored by the direct impacts on the insecticide on the insect populations (thus preventing defoliation) and by monitoring the amount of protected foliage. Longer-term effectiveness can be determined by continued monitoring of the foliage and stand conditions the following year.

The following aspects will be monitored:

- ✓ Pre-spray insect populations - Beginning early in the spring, several weeks prior to anticipated spray dates, entomologists will begin monitoring the proposed treatment areas to determine the status of insect populations. Spray blocks will be dropped and boundaries adjusted based on the local insect populations. In addition, insect-sampling plots will be established to determine the actual insect population levels, and insect development. An estimate of the defoliation that may have already occurred from feeding of very young larvae will also be made. Plots will also be established in untreated areas in order to compare effects of treatment versus no treatment.
- ✓ Post-treatment monitoring – Insect populations and foliage will continue to be monitored during periodic intervals (such as 7, 14, and 21 days) following treatment to assure continued larval mortality.
- ✓ The following aspects will be monitored for foliage protection and tree mortality:

- ✓ Foliage protection – estimates of tree defoliation will be made on specific plot trees just prior to treatment and at periodic intervals following treatment. Because of the nature of the biological insecticides, some additional feeding and loss of foliage can be expected. Defoliation will also be monitored through the annual aerial detection survey conducted during late summer and any defoliation occurring on the treated areas will be classified according to intensity.

- ✓ Long-term foliage protection – Plots and sample trees will be revisited during the fall of the following year to measure any defoliation and tree mortality that may have occurred. Defoliation will also be monitored for a second year though the annual aerial detection survey during late summer.

APPENDIX J: RESIDENTIAL, ADMINISTRATIVE & RECREATION SITES

Tables J-1: Colville National Forest

RECREATION SITE NAME	ACRES IN HOST TYPE
Bead Lake	810
Canyon Creek Campground	55
Ione City Campground	2,900
Lake Ellen Campground	210
Marshall Lake	290
Panhandle Campground	55
Pierre Lake Campground	110
Pioneer Campground	10
Sullivan Lake	1,020
Swan Lake Recreation Area	1,380
Trout Lake Campground	200
Wolfe Addition	60
TOTAL	7,100

RESIDENTIAL/ADMIN. SITE NAME	ACRES IN HOST TYPE
none	0

Tables J-2: Okanogan National Forest

RECREATION SITE NAME	ACRES IN HOST TYPE
Andrews Creek Trailhead	2
Antoine Trailhead	10
Ballard Campground	10
Beaver Lake Campground	2
Beth Lake Campground	20
Big Tree Botanical Area	10
Billygoat Trailhead	5
Black Canyon Snowpark	1
Blackpine Lake Campground	35
Bonaparte Lake Campground	20
Buck Lake Campground	10
Camp 4 Campground	2
Cedar Creek Trailhead	10
Chewuch Campground	3
Chickadee Trailhead	5
Cottonwood Campground	3
Crater Creek Trailhead	3
Crawfish Lake Campground	15
Cutthroat Trailhead	2
Eagle Creek Trailhead	10
Early Winters Ski Allocation	1,070
Falls Creek Campground	2
Farewell Creek Trailhead	2
Flat Creek Campground	10
Foggy Dew Campground	2
Foggy Dew Trailhead	2
Fourteen Mile Trailhead	5
Gilbert Trailhead	10
Goat Creek Snopark	10

RESIDENTIAL/ADMIN. SITE NAME	ACRES IN HOST TYPE
Bonaparte Lake Recreation Residence	20
Boy Scout Camp	65
Kiwanis Organization Site	10
Lutheran Organization Camp	10
North Fork Salmon Recreation Residence	5
Salmon Meadows Lodge	5
Washington Pass Visitor Information Center	5
Total	120

Highlands Snopark	3
Honeymoon Campground	10
JR Campground	20
Kerr Campground/Snopark	10
Klipchuck Campground	20
Lake Creek Corral Trailhead	15
Lone Fir Campground	10
Longswamp Campground/Trailhead	1
Lost Lake Campground	20
Loup Loup Campground	30
Loup Loup Ski Bowl	315
Lyman Lake Campground	3
Monument Creek Trailhead	3
Myers Creek Trailhead	10
Mystery Campground	1
North Fork Salmon Trailhead	2
Nice Campground	5
North Summit Snopark	1
Oriole Campground	5
Poplar Flat Campground	10
Riverbend Campground	10
Road's End Campground	5
Robinson Lake Trailhead	15
Ruffed Grouse Campground	5
Salmon Meadows Campground	5
Scatter Creek Trailhead	10
South Creek Campground	5
South Fork Gold Creek Snopark	1
South Summit Snopark	15
Sugarloaf Campground	5
Sweat Creek Campground	40
Thirtymile Trailhead	10
Twisp River Horsecamp	2
Twisp River Snopark	1
War Creek Campground	5
War Creek Trailhead	5
West Fork Buttermilk Trailhead	10
Williams Creek Trailhead	10
Wolf Creek Trailhead	1
Yellowjacket Snopark	5
Total	1,950

Tables J-3: Wenatchee National Forest

RECREATION SITE NAME	ACRES IN HOST TYPE
Alder Creek Horse Camp	1
Beverly	10
Bonanza	10
Clear Lake North	1
Clear Lake South	2
Cottonwood	1
Deep Creek	2
Domke Lake	5
Eightmile	2
Fox Creek	4
Goose Creek	10
Goose Egg Mountain	5
Grouse Mountain	1
Hatchery	5
Hause Creek	2
Horseshoe Cove	2
Ice Water	1
Lake Creek	5
Mineral Springs	1
Peninsula	5
South Fork	2
South Fork Meadow	5
Swift Water	5
Taneum	10
Tronsen	10
Tumwater	2
Willows	1
Total	110

RESIDENTIAL/ADMIN. SITE NAME	ACRES IN HOST TYPE
Cliffdell	80
Entiat Summer Homes	290
Holden	90
Liberty	120
Plain Fish Lake	7,960
Rimrock	100
Valley Hi	10
Total	8,650

Tables J-4: Umatilla National Forest

RECREATION SITE NAME	ACRES IN HOST TYPE
Alder Thicket Campground	45
Big Spring Campground	10
Bluewood Ski Area	890
Bone Springs Campground	80
Bull Prairie	150
Corral	80
Dale	15
Drift Fence Campground	3
Frazier Campground	30
Goodman Spring Campground	75
Howard Creek Trailhead	65
Jubilee Lake Campground	600
Lane Creek Campground	70
Mottet	84
Olive Lake Campground	80
Rose Springs	1
Spillway	1
Spout Springs	380
Squaw Spring Campground	65
Stentz Spring	40
Target Meadows	1
Teal Spring Campground	20
Tucannon Campground	15
Tucannon Spring	30
Twin Buttes	20
Umatilla Forks Campground	120
Wallow Creek Campground	10
Welch Creek Camp	60
Wickiup Campground	60
Woodland Park Campground	70
Woodward Forest Camp	60
Total	3,230

RESIDENTIAL/ADMIN. SITE NAME	ACRES IN HOST TYPE
Clearwater Guard Station	80
Corporation Guard Station	60
Dale Compound	50
Desolation Guard Station	25
Ditch Creek	95
Frazier	60
Fremont Powerhouse	120
Little Turkey Recreation Residence	50
Long Meadows Guard Station	45
Summit Guard Station	65
Tamarack Mountain Lookout	50
Tollgate	35
Tucannon Guard Station	55
Tupper Guard Station	75
Wenatchee Guard Station	75
Total	940

Tables J-5: Wallowa-Whitman National Forest

RECREATION SITE NAME	ACRES IN HOST TYPE
Eagle Creek Wild & Scenic River	4,100
Grande Ronde Wild & Scenic River	970
Imnaha Wild & Scenic River	4,210
Joseph Creek Wild & Scenic River	10
Losting Wild & Scenic River	1,060
North Fork John Day Wild & Scenic River	230
North Powder Wild & Scenic River	360
TOTAL	10,950

RESIDENTIAL/ADMIN. SITE NAME	ACRES IN HOST TYPE
none	0

Tables J-6: Malheur National Forest

RECREATION SITE NAME	ACRES IN HOST TYPE
Buckhorn Meadow Trailhead	10
Canyon Meadows Campground	10
Canyon Mountain Trailhead	10
Crescent Campground	10
Elk Creek Campground	10
Fields Peak Trailhead	10
Lake Creek Trailhead	10
Magone Lake Campground	10
Meadow Fork Trailhead	10
Murray Campground	10
North Fork Trailhead	10
Sheep Creek Trailhead	5
Starr Campground	10
Starr Ridge Trailhead	5
Table Mountain Trailhead	5
Wickiup Campground	5
Total	140

RESIDENTIAL/ADMIN. SITE NAME	ACRES IN HOST TYPE
County Road 65 Corridor	60
Total	60

Tables J-7: Ochoco National Forest

RECREATION SITE NAME	ACRES IN HOST TYPE
Barnhouse Campground	10
Cottonwood Camp	25
Delintment Lake Campground	5
Independence Mine Trail	2,730
Little Summit Prairie Campground	2
Mud Springs Campground	5
Ochoco Divide Camp	20
Ochoco Forest Camp	1
Round Mountain Trail	1,010
Scotts Campground	1
Steins Pillar Trail	255
Walton Lake Campground	100
Whistler Campground	10
White Rock Campground	1
Wildcat Campground	15
Wildwood Campground	10
Total	4,200

RESIDENTIAL/ADMIN. SITE NAME	ACRES IN HOST TYPE
Allison Guard Station	5
Crystal Springs Camp	12
Ochoco Ranger Station	43
Private Homes on Highway 26	180
Total	240

Tables J-8: Winema National Forest

RECREATION SITE NAME	ACRES IN HOST TYPE
Odessa Campground	20
Total	20

RESIDENTIAL/ADMIN. SITE NAME	ACRES IN HOST TYPE
Lake of the Woods Summer Home Tract	75
Rocky Point Community	75
Total	150

Tables J-9: Fremont National Forest

RECREATION SITE NAME	ACRES IN HOST TYPE
None	0

RESIDENTIAL/ADMIN. SITE NAME	ACRES IN HOST TYPE
none	0

APPENDIX K: HAZARD RISK RATING AND MORTALITY RULES

Based on previous research, it is known that there are some areas where Douglas-fir tussock moth outbreaks are more likely to occur, and that there would be varying amounts of damage within these areas. Research has been able to characterize these areas based on certain vegetation and geographical features. Rather than assume that the same infestation levels, damage, and mortality would occur across the entire analysis area (and thus overestimate the extent and amount of damage), the Forest Service has developed general hazard/risk rating rules. These rules were designed to distinguish between high, moderate, and low risk areas. They are used to provide a percentage of the analysis areas in each category, and are intended to be used as aides in developing more realistic analyses scenarios. Distinction needs to be made between an estimate of how much area is likely to incur damage and where that damage might actually occur. It cannot be assumed that DFTM infestation would occur in, and cause significant damage, only to high or even moderate risk areas, and decisions for treatment cannot be made on the basis of these rules.

High Risk Areas in Washington

- ❖ Aspect 135 degrees to 270 degrees or slope < 10% and
- ❖ Elevation ≤ 4,500 feet and
- ❖ Host type 60-100% and
- ❖ Small to Large trees and
- ❖ Crown Closure > 60%

High Risk Areas in Oregon

- ❖ Aspect 90 to 270 degrees or slope < 10% and
- ❖ Elevations ≤ 8,000 feet and
- ❖ Host type 60-100% and
- ❖ Small to Large trees and
- ❖ Crown Closure > 70%

Moderate Risk In Washington

- ❖ Any Aspect and
- ❖ Elevation ≤ 4,500 feet and
- ❖ Host 20-60% or 60-100% and
- ❖ Small to Large trees and
- ❖ Crown Closure > 30%

Moderate Risk in Oregon

- ❑ Any Aspect and
- ❑ Elevation ≤ 8,000 feet and
- ❑ Host 20-60% or 60-100% and
- ❑ Small to Large trees and
- ❑ Crown Closure > 30%

Low Risk in Washington and Oregon

All host type not in above 2 categories. This would include saplings and smaller stands, elevations above 4,500 feet in Washington or 8,000 feet in Oregon, and low density stands.

The Umatilla and Wallowa-Whitman NF's had already developed DFTM Risk areas in previous analyses and these were used rather than the above rules for those Forests.

DEFOLIATION ANALYSIS

Varying degrees of defoliation and subsequent mortality would occur throughout the potential DFTM outbreak area. There would be 100% defoliation and mortality on just a percentage of the area. Other parts of the outbreak area will receive moderate defoliation and some mortality, and other areas will have light defoliation and no mortality. In order to assign a reasonable measure or percentage of the analysis area that would receive various levels of defoliation and mortality, biologists developed analysis guidelines.

First, an estimate was made as to how much of the analysis area would fall into the light, moderate and heavy defoliation categories. The hazard/risk map divides the potential outbreak area into areas of high, moderate, and low risk; and to some extent, although it was not the intended use of this map, the severity of the defoliation in those areas can be inferred. It is possible that a low risk area could in fact receive heavy mortality, or visa versa. This map helps establish a reasonable estimate of actual mortality across the potentially affected area. Since it is not known exactly where the DFTM outbreaks would occur, over four million acres is analyzed under the No Action alternative in this document. Using the 1972 – 1974 outbreak as a reference, it is likely that a new outbreak will occur on 16% (approximately 700,000 acres) of the affected areas. Based on site characteristics such as slope, aspect, and percent of host type, the analysis area has been classified into high, moderate, and low risk to DFTM outbreak and damage. Within the 700,000 acres, it is estimated that 65% would be designated as high risk, 30% would be medium risk, and 5% would be low risk.

The categories for the risk map are high, moderate, and low. For the development of the risk map it was assumed the following defoliation levels would occur in the following risk categories:

Low = Light defoliation; less than 40%,

Moderate = Moderate defoliation is 40-60%

High = Heavy defoliation is over 60%

Wickman (1979) developed a table to predict mortality for Douglas-fir and true fir based on defoliation class. This rating system was intended for predicting individual tree mortality; however, it is used here a guide for estimating the amount of average mortality to be expected within each defoliation category.

For Light Defoliation, the estimated mortality based on defoliation of less than 40% (defoliation classes 1 and 2) is

less than .5% for grand fir and less than 2.25% for Douglas-fir; the average of less than 1.25% mortality is so low that for Light Defoliation areas, it is assumed there would be no 0% or mortality from DFTM.

For Moderate Defoliation: the estimated mortality based on defoliation of 50% (defoliation class 3) for grand fir is 2% and for Douglas-fir is 8%, with an average of 5% mortality to be expected.

For Heavy Defoliation the estimated mortality based on an average of classes 4-7 (75% or greater defoliation) for each species. The average mortality for grand fir was 53% and for Douglas-fir, 43%, to obtain an overall average of 48% mortality.

The above represents expected mortality from DFTM defoliation alone. The risk of secondary mortality from bark beetles is based, to some extent, on the same factors.

The following table is developed to provide a guide in determining mortality by size class from defoliation alone, a combination of defoliation and bark beetles, with no bark beetles in the vicinity, and mortality from defoliation and bark beetles with a currently existing bark beetle population in the area.

DEFOLIATION RULES

To aid in the analysis, the 1997/1998 bark beetle layers from the annual aerial detection survey have been overlaid on the alternatives for each Forest. This resulted in a recommendation for identifying which of the mortality rules apply based on occurrence of bark beetles. Some Forests have two distinct parts and in some cases, there were differences with regard to the presence of bark beetles.

Table K-1: Mortality Estimates

Tree Size	Low Risk <40% Defoliation	Moderate Risk 40-60% Defoliation	High Risk > 60% Defoliation
Trees over 21" DBH	Estimated mortality from defoliation alone = 0%	Estimated mortality from defoliation alone = 5%	Estimated mortality from defoliation alone = 48%
	Estimated mortality from defoliation and bark beetles if bark beetles are not currently in the area = 3%	Estimated mortality from defoliation and bark beetles if bark beetles are not currently in the area = 12%	Estimated mortality from defoliation and bark beetles if bark beetles are not currently in the area = 61%
	Estimated mortality from defoliation and bark beetles if bark beetles are in the area = 6%	Estimated mortality from defoliation and bark beetles if bark beetles are in the area = 25%	Estimated mortality from defoliation and bark beetles if bark beetles are in the area = 70%
Trees 14 – 24" DBH	Estimated mortality from defoliation alone = 0%	Estimated mortality from defoliation alone = 5%	Estimated mortality from defoliation alone = 48%
	Estimated mortality from defoliation and bark beetles if bark beetles are not currently in the area = 3%	Estimated mortality from defoliation and bark beetles if bark beetles are not currently in the area = 12%	Estimated mortality from defoliation and bark beetles if bark beetles are not currently in the area = 61%
	Estimated mortality from defoliation and bark beetles if bark beetles are in the area = 6%	Estimated mortality from defoliation and bark beetles if bark beetles are in the area = 25%	Estimated mortality from defoliation and bark beetles if bark beetles are in the area = 70%
Trees 9 – 14" DBH	Estimated mortality from defoliation alone = 0%	Estimated mortality from defoliation alone = 5%	Estimated mortality from defoliation alone = 32%
	Estimated mortality from defoliation and bark beetles if bark beetles are not currently in the area = 2%	Estimated mortality from defoliation and bark beetles if bark beetles are not currently in the area = 5%	Estimated mortality from defoliation and bark beetles if bark beetles are not currently in the area = 34%
	Estimated mortality from defoliation and bark beetles if bark beetles are in the area = 4%	Estimated mortality from defoliation and bark beetles if bark beetles are in the area = 7%	Estimated mortality from defoliation and bark beetles if bark beetles are in the area = 37%

Table K-2: Colville NF Mortality Rules

Forest-wide	
Proposed Action and TM-BioControl Only Action	Use mortality from defoliation with no bark beetles in the area
Expanded Protection Action	Use mortality from defoliation with no bark beetles in the area
No Action	Use mortality from defoliation with no bark beetles in the area
East half only	
Proposed Action and TM-BioControl Only Action	Use mortality from defoliation with no bark beetles in the area
Expanded Protection Action	Use mortality from defoliation with bark beetles in the area
No Action	Use mortality from defoliation with bark beetles in the area
West half only	
Proposed Action and TM-BioControl Only Action	Use mortality from defoliation with no bark beetles in the area
Expanded Protection Action	Use mortality from defoliation with no bark beetles in the area
No Action	Use mortality from defoliation with no bark beetles in the area

Table K-3: Okanogan NF Mortality Rules

Forest-wide Basis	
Proposed Action and TM-BioControl Only Action	Use mortality from defoliation with no bark beetles in the area
Expanded Protection Action	Use mortality from defoliation with bark beetles in the area
No Action	Use mortality from defoliation with no bark beetles in the area
East half only	
Proposed Action and TM-BioControl Only Action	Use mortality from defoliation only
Expanded Protection Action	Use mortality from defoliation only
No Action	Use mortality from defoliation only
West half only	
Proposed Action and TM-BioControl Only Action	Use mortality from defoliation with no bark beetles in the area
Expanded Protection Action	Use mortality from defoliation with bark beetles in the area
No Action	Use mortality from defoliation with bark beetles in the area

Table K-4: Wenatchee NF Mortality Rules

Forest-wide	
Proposed Action and TM-BioControl Only Action	Use mortality from defoliation with bark beetles in the area
Expanded Protection Action	Use mortality from defoliation with bark beetles in the area
No Action	Use mortality from defoliation with bark beetles in the area

Table K-5: Umatilla NF Mortality Rules

Forest-wide	
Proposed Action and TM-BioControl Only Action	Use mortality from defoliation with no bark beetles in the area
Expanded Protection Action	Use mortality from defoliation with no bark beetles in the area
No Action	Use mortality from defoliation with bark beetles in the area
North half only	
Proposed Action and TM-BioControl Only Action	Use mortality from defoliation with bark beetles in the area
Expanded Protection Action	Use mortality from defoliation with bark beetles in the area
No Action	Use mortality from defoliation with bark beetles in the area
South half only	
Proposed Action and TM-BioControl Only Action	Use mortality from defoliation with no bark beetles in the area
Expanded Protection Action	Use mortality from defoliation with no bark beetles in the area
No Action	Use mortality from defoliation with bark beetles in the area

Table K-6: Wallowa-Whitman NF Mortality Rules

Forest-wide	
Proposed Action and TM-BioControl Only Action	Use mortality from defoliation with bark beetles in the area
Expanded Protection Action	Use mortality from defoliation with bark beetles in the area
No Action	Use mortality from defoliation with bark beetles in the area
East half only	
Proposed Action and TM-BioControl Only Action	Use mortality from defoliation with bark beetles in the area
Expanded Protection Action	Use mortality from defoliation with bark beetles in the area
No Action	Use mortality from defoliation with bark beetles in the area
West half only	
Proposed Action and TM-BioControl Only Action	Use mortality from defoliation with no bark beetles in the area
Expanded Protection Action	Use mortality from defoliation with no bark beetles in the area
No Action	Use mortality from defoliation with no bark beetles in the area

Table K-7: Malheur NF Mortality Rules

Forest-wide	
Proposed Action and TM-BioControl Only Action	Use mortality from defoliation with no bark beetles in the area
Expanded Protection Action	Use mortality from defoliation with no bark beetles in the area
No Action	Use mortality from defoliation with no bark beetles in the area
North half only	
Proposed Action and TM-BioControl Only Action	Use mortality from defoliation with no bark beetles in the area
Expanded Protection Action	Use mortality from defoliation with no bark beetles in the area
No Action	Use mortality from defoliation with bark beetles in the area
South half only	
Proposed Action and TM-BioControl Only Action	Use mortality from defoliation only
Expanded Protection Action	Use mortality from defoliation only
No Action	Use mortality from defoliation only

Table K-8: Ochoco NF Mortality Rules

Forest-wide	
Proposed Action and TM-BioControl Only Action	Use mortality from defoliation with no bark beetles in the area
Expanded Protection Action	Use mortality from defoliation with no bark beetles in the area
No Action	Use mortality from defoliation with no bark beetles in the area

Table K-9: Winema NF Mortality Rules

Forest-wide	
Proposed Action and TM-BioControl Only Action	Use mortality from defoliation only
Expanded Protection Action	Use mortality from defoliation with no bark beetles in the area
No Action	Use mortality from defoliation with no bark beetles in the area

Table K-10: Fremont NF Mortality Rules

Forest-wide	
Proposed Action and TM-BioControl Only Action	Use mortality from defoliation only
Expanded Protection Action	Use mortality from defoliation only
No Action	Use mortality from defoliation only

APPENDIX L: LOCATION OF OLD-GROWTH/LOS

The following identifies where old-growth and late/old structures are located.

Colville National Forest

Host type areas have not been identified.

Okanogan National Forest

Old growth and late/old structure stands are concentrated in the following areas:

- Jakita Ridge, in the Pasayten Wilderness: 7,400 acres of host type; 9,000 acres of non-host.
 - North Cascades Scenic Highway Corridor: 8,600 acres of host type; 10,000 acres of non-host. This includes spotted owl nesting habitat.
 - Yellowjacket: 3,800 acres of host type; 3,700 acres of non-host. This includes spotted owl nesting habitat.
 - Chewuch River Basin: 9,800 acres of host type; 8,800 acres of non-host. The West Chewuch Road, a scenic corridor, runs through this area.
 - Fawn Creek Basin: 7,400 acres of host type; 8,000 acres of non-host. Parts of this area are in the Highway 20 scenic corridor.
 - Early Winters Creek: 7,400 acres of host type; 4,000 acres of non-host. This includes spotted owl habitat and the Highway 20 scenic corridor.
 - Upper Twisp River: 8,600 acres of host type; 3,500 acres of non-host. This includes some spotted owl nesting habitat, and the Twisp River Road scenic corridor.
 - Virginian Ridge: 8,800 acres of host type; 8,500 acres of non-host.
 - Gold Creek: 5,000 acres of host type; 3,200 acres of non-host.
 - Salmon Creek: 5,000 acres of host type; 3,200 acres of non-host. This includes the State Road 38 scenic corridor.
 - Mount Hull: 8,600 acres of host type; 1,100 acres of non-host.
 - Big Tree Botanical Area: 8,600 acres of host type.
 - Dugout: 6,200 acres of host type; 2,200 acres of non-host.
 - Cedar Creek: 6,000 acres of host type.
 - Buck Mountain: 5,200 acres of host type; 2,800 acres of non-host.
 - Another 2,000 acres of host type and 2,700 acres of non-host are scattered throughout the Forest.
- ### Wenatchee National Forest
- Old growth that includes host type stands is concentrated in the following areas:
- Lake Chelan Recreation Area (North Cascades National Park): 5,000 acres of host type; 6,500 acres of non-host.
 - Bear Creek to Little Big Creek, along Lake Chelan: 4,500 acres of host type; 6,600 acres of non-host.
 - Mad River: 3,00 acres of host type; 15,000 acres of non-host.

Baldy: 2,000 acres of host type; 8,000 acres of non-host.
Chumstick Mountain: 3,000 acres of host type; 3,500 acres of non-host.

Dinkelman Ridge: 500 acres of host type; 8,000 acres of non-host.

Tronsen Creek: 3,000 acres of host type; 3,000 acres of non-host.

Mission Ridge: 4,000 acres of host type; 7,500 acres of non-host.

Cougar Gulch: 5,000 acres of host type; 2,000 acres of non-host.

William O. Douglas Wilderness: 500 acres of host type; 150,000 acres of non-host.

The following areas have old growth with no host type:

Glacier Peak Wilderness: 20,000 acres.

Chiwawa River: 40,000 acres.

Henry Jackson Wilderness: 135,000 acres.

Alpine Lakes Wilderness: 23,500 acres.

Cle Elum Lake: 16,000 acres.

Teanaway Ridge: 20,000 acres.

Manashtash Creek: 20,000 acres.

Umatilla National Forest

Late/old structure stands are concentrated in the following areas:

The largest continuous block of old growth, 2,050 acres, is in the Wenaha-Tuscannon Wilderness. It includes about 500 acres of host type.

The head of Jug Creek includes a 1,800-acre block, which is 50% host type.

There are scattered patches totaling about 2,000 acres in the Vinegar Hill area, on the other side of the ridge from old growth on the Malheur National Forest. These patches are about 60% host type.

There is a 500-acre patch near the Ruby Creek Mines, along the boundary with the Wallowa-Whitman National Forest. It is about 50% host type.

Between the Wenaha-Tuscannon Wilderness and Highway 84 there are about 20 patches of old growth totaling 11,000 acres. These are 95% host type.

There are 6 old growth patches along the Grande Ronde River, on the boundary with the Wallowa-Whitman National Forest. They total 1,000 acres, and are primarily host type.

North of the Wenaha-Tuscannon Wilderness are 10 patches of old growth totaling 1,400 acres. These are about 50% host type.

West of the North Fork John Day Wilderness are 20 patches of old growth totaling 4,250 acres. These are primarily host type.

Wallowa-Whitman National Forest

The only extensive areas on the Wallowa-Whitman where late/old structure stands are not found are along the Snake River, and at high elevations near Eagle Cap.

Malheur National Forest

On the Malheur National Forest, late/old structure stands are concentrated in the following areas:

A unique stand of Alaska yellow cedar on the Bear Valley District is part of a 5,000-acre area of late/old structure. This area is about 80% host type. About 10% is considered to be at high risk for defoliation; the rest is moderate risk.

There is a 400-acre stand of late/old structure in the head of the Canyon City watershed, which is entirely host type at moderate risk.

About 4,000 acres of late/old structure is found on the boundary between the Bear Valley and Prairie City Ranger Districts. This is west of the Snowshoe Fire, along the visual corridor to Indian Creek Trailhead. Several dedicated old growth stands are included in this area. About 80% of the late/old structure is dominated by host type at moderate risk.

About 3,000 acres of late/old structure, including three small areas of dedicated old growth, are part of the visual corridor into the east side of Bear Valley Ranger District. About 60% of this area is dominated by host type, with non-host late/old structure mostly on the west end. About 10% of host type is high risk, and the rest is moderate risk.

The Upper Deer Creek Sub watershed contains about 6,400 acres of late/old structure, which is about 60% host type at moderate risk.

The Magone Lake area contains about 500 acres of late/old structure. About half of this is host type at moderate risk.

There is about 200 acres scattered late/old structure in Vinegar Creek, about half of which is host type at moderate risk.

The Middle Fork of the John Day River Headwaters contains about 6,000 acres of late/old structure, including several stands of dedicated old growth. It is about 60% host type. About 20% of the host type is high risk; the rest is moderate risk.

The Genesis Project Area old growth stands total about 1,000 acres, and is almost entirely host type at moderate risk.

The Reynolds area includes about 6,000 acres of late/old structure. Some of these areas are dedicated old growth. It is about 80% host type at moderate risk.

The Phink/Elk area includes about 6,000 acres of late/old structure, including several dedicated old growth stands. It is about 90% host type at moderate risk.

The John Day Headwaters contains about 5,000 acres of late/old structure that is almost entirely host type. About 5% is high risk; the rest is moderate risk.

The Wickiup area contains about 7,300 acres of late/old structure, including several dedicated old growth stands. These stands are about 70% host type at moderate risk.

Ochoco National Forest

On the Ochoco National Forest, late/old structure stands are concentrated in the following areas:

The Lookout Mountain Management Area, including the Ochoco Ranger Station, has about 79,000 acres: 64,000 acres of host type, and 15,000 acres of non-host. It includes 2 stands of designated old growth in host type, totaling 500 acres.

The Black Canyon Wilderness Area has 47,500 acres: 35,000 acres of host type, and 12,500 acres of non-host.

The Bridge Creek Wilderness Area has 22,500 acres: 17,500 host type, and 5,000 acres of non-host. It includes one stand of designated old growth, about 700 acres, in host type. This includes the Mitchell Municipal Watershed.

The Mill Creek Wilderness Area has 20,000 acres, about 10,000 acres of host type and 10,000 non-host types.

The Highway 26 corridor has 10,000 acres, about evenly divided between host and non-host.

The north half of the Paulina Ranger District has about 57,250 acres: 52,250 of host type, and 5,000 acres of non-host. It includes 21 stands of designated old growth, about 2,000 acres, mostly in host type.

The south half of the Paulina Ranger District has about 25,000 acres, primarily non-host. It includes 6 stands of designated old growth, totaling about 500 acres. One of these stands is in host type, about 100 acres.

The north end of the Big Summit Ranger District has about 40,000 acres: 30,000 acres of host type, and 10,000 acres of non-host. It includes 14 stands of designated old growth, about 1,500 acres, primarily in host type.

Ochoco Divide RNA has about 10,000 acres, almost entirely host.

The Silver Creek RNA has about 40,000 acres, almost entirely non-host.

Allison Spring has about 10,000 acres, almost entirely non-host.

The Snow Mountain District outside of Allison Spring and the Silver Creek RNA has about 54,250 acres, primarily non-host. It includes 24 stands of designated old growth, about 1,200 acres. One of these stands, about 500 acres, is in host type.

About 10,000 acres of other scattered late/old stands can be found throughout the Forest. These are about evenly divided between host and non-host.

Winema National Forest

Old growth stands are concentrated in the following areas:

Jackson Creek area: 15,500 acres of host-type; 50,000 acres of non-host.

The area bordered by Klamath Marsh, the Williamson River, and the Sprague River: 10,000 acres of host-type; 60,000 acres of non-host.

Chiloquin Ridge and vicinity: 20,200 acres of host-type; 3,500 acres of non-host. Host type stands include habitat for spotted owl. Tussock moth has been observed in this area.

The area between Sun Mountain Road and Crater Lake: 4,500 acres of host-type; 4,000 acres of non-host.

Sky Lakes Wilderness: 15,000 acres of host-type; 23,000 acres of non-host.

Lake of the Woods Resort: 18,500 acres of host-type; 0 non-host.

From Sevenmile Creek south to Mountain Lakes

Wilderness, east of Sky Lakes Wilderness: 11,000 acres of host-type, 1,500 acres of non-host. Host-type includes about 8,700 acres around rare algae in Mare's Egg Spring and an isolated bull trout reach in Threemile Creek. Tussock moth has been observed in this area.

Other clumps of old growth scattered throughout the Forest: about 1,500 acres, primarily non-host.
Fremont National Forest

Old growth stands are concentrated in the following areas:

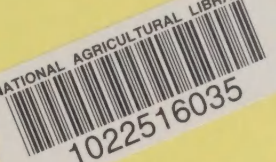
Cabin Lake/Fort Rock Wildlife Area: 20,000 acres.

Yamsay Mountain Recreation Area: 15,000 acres.


Between Summer Lake and the Sycan River: 20,300 acres.

Crane Mountain Recreation Area: 3,000 acres.

Other clumps of old growth scattered throughout the Forest: 4,000 acres.

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